A STUDY TO DETERMINE

IF PHARMACEUTICAL COST IS RELATED TO DIAGNOSTIC COMPLEXITY FOR THE TREATMENT OF ESSENTIAL HYPERTENSION PATIENTS AT WOMACK ARMY COMMUNITY HOSPITAL

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This study was performed to determine if pharmaceutical cost is related to diagnostic complexity for the treatment of essential hypertension patients at Womack Army Community Hospital. The results of this study indicated that there was a low relationship between pharmaceutical cost and diagnostic complexity.

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INTRODUCTION

I. CONDITIONS WHICH PROMPTED THE STUDY

The United States spends an enormous and rapidly expanding number of health care dollars. Since 1952, per capita health care expenditures have nearly tripled.

More recently, total national health care expenditures have grown from $322 billion in 1982, to $355 billion in 1983, to approximately $390 billion in 1984 (Morreim, 1984, p. 257) to approximately $410 billion in 1985 and now represent more than ten percent of the Gross National Product. This figure is expected to rise to $690 billion by 1990, and to $1.9 trillion by the year 2000, for an average annual increase of $50 billion per year, or a doubling of expenditures every six years (Morreim, 1984, p. 257).

Womack Army Community Hospital (WACH) is a 288 bed general medical fixed treatment facility which has experienced a growth in net expenditures from $21,090,400 in 1983, to $25,994,600 in 1986, representing an average annual increase of 5.8 percent. However, the growth in pharmacy expenditures over this period was of great concern to the executive management of WACH. The pharmacy budget increased from $3,571,227 in 1983, to $4,574,837 million in 1986, for an average annual increase of 7.03 percent. This higher growth rate in the pharmacy budget prompted questions such as: Can WACH predict pharmacy costs? What factors influence pharmacy costs? Can the pharmacy budget be contained or controlled? These questions ultimately led to the development of this study.

The specialty of hospital pharmacy has been defined as follows:

> .....the department or service in a hospital which is under the direction of a professionally competent pharmacist, and from which all medications are supplied to the nursing units and other services, where special prescriptions are filled for patients in the hospital, where pharmaceuticals are manufactured in bulk, where prescriptions are filled for ambulatory patients and outpatients, where narcotic and other prescribed drugs are dispensed, where biologicals are stored and dispensed, where injectable preparations should be prepared and sterilized, and where professional supplies are often stocked and dispensed. (Hassan, 1981).

Special interest must be given, however, to the dispensing of prescriptions to ambulatory and outpatients within the context of recent trends by hospitals to deliver a greater variety and complexity of ambulatory services. These trends can be attributed to a multitude of factors, to include: changes in reimbursement mechanisms, decreased inpatient hospital utilization, increased competition in ambulatory services, increased numbers of physicians, changing medical technologies, and a cost sensitive United States Congress.

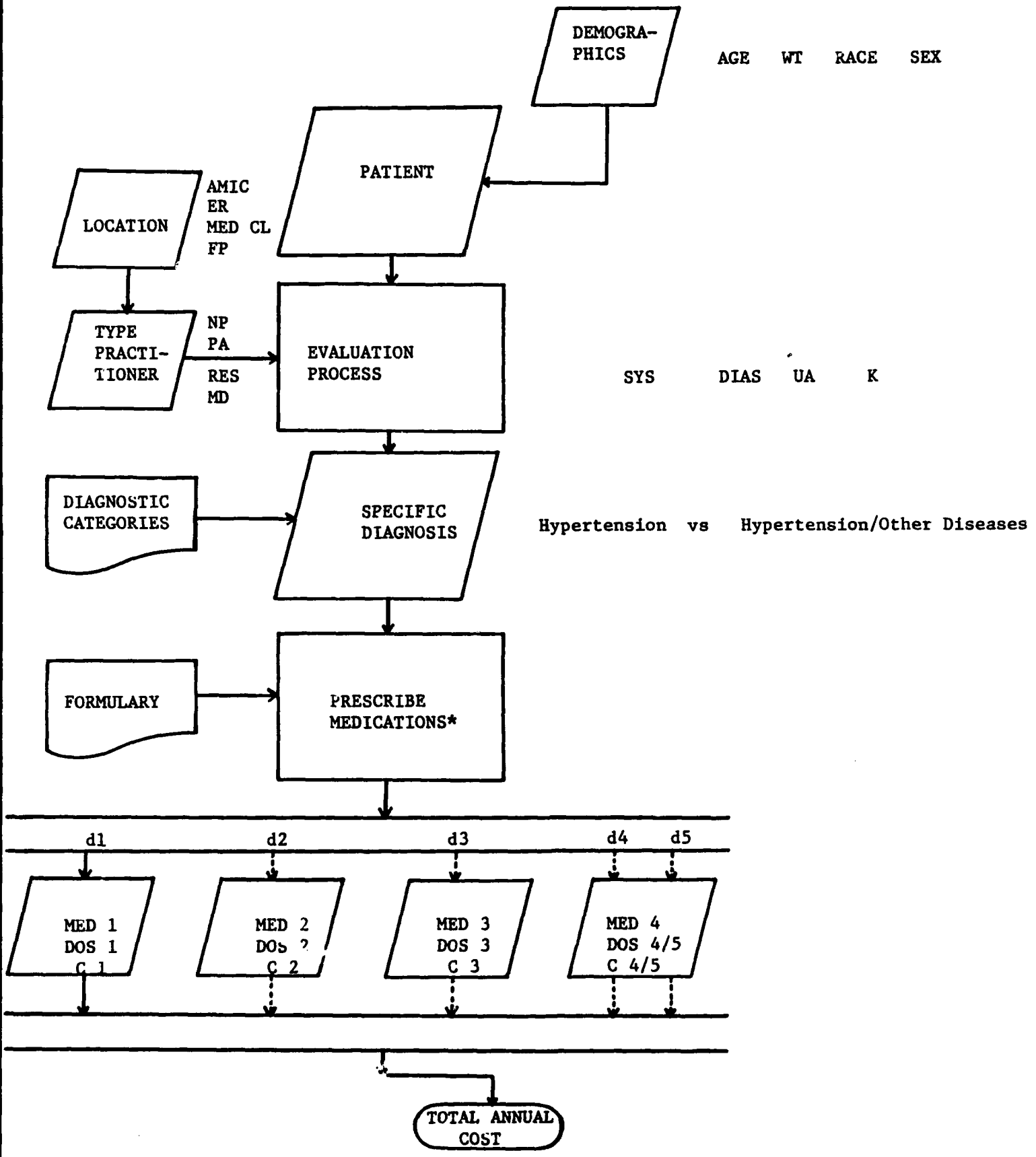
As these factors alter the practice of medicine in this health care delivery system and place greater emphasis on the provision of ambulatory services, hospital pharmacists will be called upon to provide more comprehensive, efficient, and cost effective outpatient pharmacy services. This can be accomplished through the exercise of sound management. For the purposes of this paper, management will be defined as "the process of planning, organizing, directing, and controlling organizational activities." (Daft, 1984; Katz and Kahn, 1978).

In the process of managing outpatient pharmacy services, primary consideration must be given to the planning function as it relates to the ability of the manager (pharmacist) to provide the mix of services and products (prescriptions) required by the health care provider and patient at some point in time. Since the provision of these services and products directly translates into future pharmacy budget requirements, a more thorough understanding of the patient-physician interaction, which generates these requirements, is warranted.

The conceptual model of the patient-physician interaction, to be used as the basis for this study, is shown in Illustration 1.

Illustration 1

Patient-Practitioner Interaction Model



* More than one medication may be prescribed.

From a local demographic population base, a specific patient enters a medical treatment facility (MTF) and encounters a practitioner at a specific location within the facility who initiates an evaluation process. This process would include such activities as patient history, vital signs, triage, ancillary diagnostic support (laboratory, xray, etc.), and all other activities that lead to a diagnosis. Systolic blood pressure, diastolic blood pressure, plasma potassium (K) level, and plasma uric acid (UA) level will be the most important clinical indicators with regard to hypertension. Once a diagnosis is determined, essential hypertension or essential hypertension with the presence of other diseases, the provider then develops a treatment plan which generally includes the prescribing of specific medications. For purposes of this study, all medications under consideration are included in the MTF formulary and will be categorized as MED1, MED2, MED3, or MED4. These categorized medications have specific dosages (DOS1, DOS2,...DOS5) and associated unit costs (C1, C2,...C5) from which a total annual cost can be computed. Medication unit costs can be found in Appendix A. In some instances patients may receive more than one medication which may or may not fall into the same medication category.

As illustrated by this model, a number of key variables must be considered in any attempt to accurately predict and/or contain pharmacy costs. These may include: the individual patient, demographics of the population base, specific epidemiologic conditions, diagnostic sophistication, and the decision criteria of the prescribers in choosing pharmacologic agents. Pharmaceutical factors to be considered include drug cost at specific work load volumes, inflation, change in accepted drug therapies, and formulary restrictions.

Of elemental concern, however, must be the need to identify the resources used, such as pharmaceuticals, in caring for patients with specific diseases (Arbgeit, et al. 1985). As the patient-physician interaction model depicts, pharmaceutical utilization is diagnosis driven. Although one could predict the epidemiology of these specific conditions, there is currently no documented analyses of pharmaceutical utilization by specific diagnosis and only one study with regard to diagnostic related groups (DRG) (Phillips, et al., 1986).

In understanding the relationship between necessary pharmaceutical resources and specific diagnosis, one can begin to visualize and appreciate how provider practice patterns may influence the utilization of those resources. Thus, in any pharmacy cost prediction or cost containment model, one should consider and account for the variation in practitioner prescribing patterns.

Additionally, specific patient characteristics may influence the type and therefore the cost of medications prescribed. These characteristics contribute to diagnostic complexity, and would include specific clinical indicators and demographic variables which could assist the physician in making a drug decision to achieve treatment success. Increased diagnostic complexity would generally be expected to increase the cost of the pharmaceuticals utilized, just as DRG reimbursement rates increase for more complex clinical conditions. Resource managers can, therefore, accept higher pharmaceutical costs based on therapeutic necessity, but not for changes in prescriber patterns without clinical justification. If prescribing patterns are consistent for individual prescribers who treat patients with specific diagnoses, one would expect increased accuracy in cost predictions using this epidemiologic model.

A study to fully develop this concept cannot be conducted at this Medical Treatment Facility (MTF) due to an insufficient number of prescribing practitioners who treat hypertensive patients. However, a specific diagnosis of hypertension was chosen for study because (1) it was found to be one of the top ten ambulatory diagnoses and (2) it demonstrated a large financial impact on the pharmacy service (600K in FY86). This study will examine the potential relationship of patient diagnostic complexity to the cost of the pharmaceutical resources utilized while controlling for the location in the MTF and the type of practitioner seen. Diagnostic complexity for essential

hypertension will be defined as consisting of the following clinical indicators: systolic and diastolic blood pressure measurements, interstitial potassium and uric acid levels; demographic variables, age, weight, race and sex; and the control factor presence of other diseases. The clinical indicators contribute to diagnostic complexity of essential hypertension when their measured values fall above or below normally accepted ranges, while the demographic variables and control factor have been found to be associated with increased risk and/or increased morbidity of hypertension (Kaplan, 1986).

II. STATEMENT OF THE PROBLEM.

To determine if pharmaceutical cost is related to diagnostic complexity for the treatment of essential hypertension patients at Womack Army Community Hospital (WACH).

III. OBJECTIVES.

The objectives of this study are to:

a. Conduct a literature review on physician prescribing patterns and treatment protocols for hypertension, and determine their relationship to cost containment and/or predictability of pharmacy budget requirements.

b. Develop an audit list of hypertensive patients treated at WACH using the Ambulatory Care Data Base (ACDB).

c. Develop a data base of the clinical indicators (systolic and diastolic blood pressure, plasma uric acid and potassium levels), demographic variables (age, weight, race, and sex) and control factors (presence of other diseases, location within the MTF, and type of practitioner).

d. Develop an index to measure medication complexity along a scale of least to most complex based on type of dose and medications.

e. Develop an index to measure type of practitioner along a scale of scope of practice.

f. Determine the relationship between the demographic variables (age, weight, race and sex), the clinical indicators (systolic and diastolic blood pressure, and plasma uric acid and potassium levels) with medication complexity and/or annual pharmaceutical cost controlling for the presence of other diseases, location within the MTF (Acute Minor Illness Clinic, Medical Clinic, Emergency Room, and Family Practice Clinic) and the type of practitioner who initiated treatment (Nurse Practitioner, Family Practice Resident, Physician Assistant, and Staff Physician).

g. Determine how well these clinical indicators justify annual pharmacy cost.

IV. CRITERIA.

Statistical tests will be conducted for an alpha equal to .05. This power of statistical testing was found frequently in the literature review of related topics. At this level of significance, standardized two-way statistical test results would be required to exceed 1.96 standard deviations from the mean.

Hypothesis testing will be conducted for H_0 : $B \neq 0$ and H_A : $B = 0$. In testing the alternate hypothesis H_A, pharmaceutical costs are not related to the demographic variables and clinical indicators chosen, the beta values of each exogenous variable chosen should not be significantly different than zero. Therefore, one would choose in favor of the null hypothesis, H_0. Good predictors of pharmaceutical cost would be those beta values statistically significant from zero.

V. ASSUMPTIONS/LIMITATIONS.

a. Assumptions

1. Data collected for ACDB is accurate and correct. This must be assumed since there is no practical way to verify the data.

2. Data collected from the patient medical record is accurate and correct. This must be assumed since there is no practical way to verify the data.

b. Limitations:

1. Hospital formularies may vary substantially and thus alter and/or limit the similarity of related studies.

2. The annual pharmaceutical cost per patient (endogenous variable), will be calculated based on the initial treatment regimen. While this avoids the pitfalls of being influenced by dispensing policies and/or restrictions subsequent to initial treatment, it may not represent the true cost actually realized by the MTF in the short term, but provides a basis from which to make long term cost comparisons.

3. The professional judgements/preferences of providers in prescribing specific medications may conflict with the cost containment intentions of this study. This could limit the results and the implementation of any cost containment programs.

4. A study to fully develop this concept cannot be conducted a this Medical Treatment Facility (MTF) due to an insufficient number of prescribing practitioners who treat hypertensive patients.

VI. LITERATURE REVIEW.

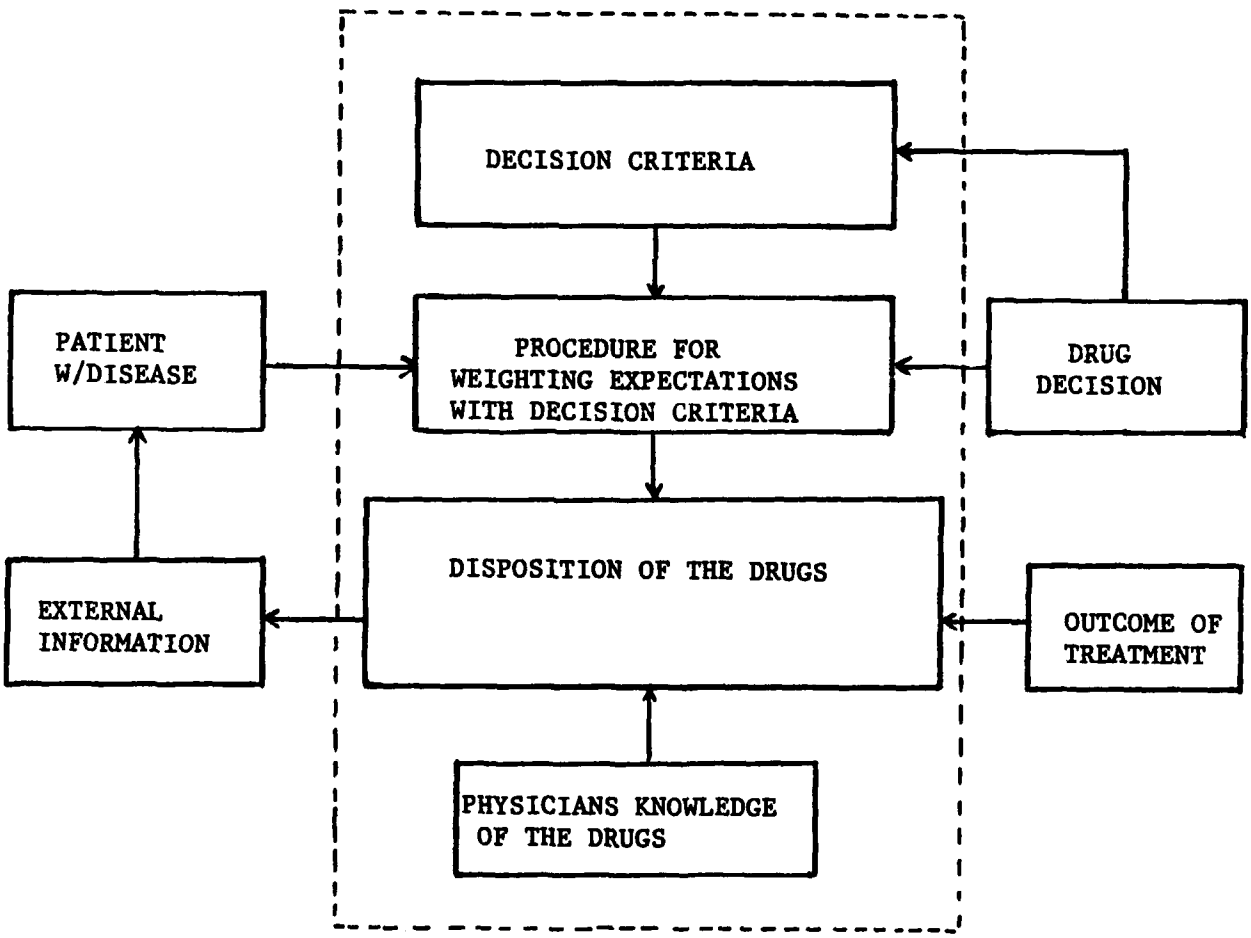
Despite the number of variables that influence the cost of medical care, and particularly the cost of pharmaceuticals, the role of the physician is a central one. While administrators are correct to closely monitor the pharmacy budget, which represented 17.6 percent of the overall WACH budget and 44.6 percent of the

WACH supply budget in FY86, literature review reveals that physicians control or influence from 50 to 80 percent of all health care expenditures (Schroeder, 1980, in Nuehauser, 1980, p.23; Eisenberg, 1984, p. S905; Williams and Torrens, 1984). Specifically, they also influence the use of ambulatory services such as pharmaceutical prescriptions (Schroeder, 1980, p.23; Shapleigh, 1985, p. 2159; Eisenberg, 1984, p. S905) thus contributing to the cost of drugs prescribed (Harding, et al. 1985, in British Medical Journal, 9 Feb 85, p. 450; Dresnech, et al., 1979, p. 1606).

John Lilja, 1976, conducted an empirical study of how physicians choose drugs. His framework identified both habitual and non-habitual choices. This paper will focus on the non-habitual model, just as Lilja's study did, since physicians are expected to choose drugs non-habitually in new therapeutic situations. The specific model is depicted in Illustration 2.

Illustration 2

Physician's Non-Habitual Choice Process*



*The Physician's non-habitual choice process, Lilja, 1976 p 363

The factors enclosed by the dotted line represent those components thought to be in the mind of the prescriber. Disposition of the drugs was found to be of central importance and was chosen because of its value in explaining common prescribing behavior (Lilja, 1976, p. 363). Disposition was defined as the physician's judgement of one brand of drug in a number of bipolar scales which reflected the decision criteria: curing effect, side effects, and cost , so chosen because they were goal dimensions in Swedish governmental investigations and regulations. Of value to this study is the concept that the decision criteria mediate the procedure for weighting the expectations of the drug choice with regard to clinical outcome.

Non-habitual prescribing patterns would be expected when the outcome of the prescribing is unsatisfactory, either because of nc curing effect or the presence of undesirable side effects. After a number of satisfactory results, the physician is expected to choose the drug habitually when confronted with the same disease in future cases. (Lilja, 1976). One would expect then, a non-habitual therapeutic choice would be made only upon an initial visit, after a treatment failure, or when patients experience excessive side effects.

Multiple regression analysis conducted on the three decision criteria (curing effect, side effects, and cost of the drug) indicated that curing effect was the most important decision criterion (B=.64), while cost of the drug was only relatively

more important (B=.19) when choosing between antibiotics versus antidiabetic medications (B=.16) (Lilja, 1976, p. 364). The results of this multi-regression analysis are reinforced by numerous other studies which have examined physician behavior with regard to cost containment (Eisenberg and Williams, 1981; Griner and Litzia, 1971; Rhyne and Gelbach, 1979; Griner, 1979; Martin, et al. and Klein, et al., 1980; Lyle et al., 1979; Robertson, 1980; Cohel et al., 1982; Cummings et al., 1982; Martin et al. 1980; Schroeder et al., 1984,; Felnio and Gagnon, 1979; Mitchell et al., 1975; Brook and Williams, 1976; Morton, 1981; Pruchhansky, 1977; Stoelwinder, 1978; Hunt, 1980). These studies and others demonstrate that, regardless of strategies used (education, peer review, administrative change, participation, penalties and rewards), physician prescribing behaviors either did not change or only changed during the study period (possible Hawthorne effect).

Upon close examination of the two previous models, the patient-physician interaction and the non-habitual prescribing models, one finds a common determinent of the pharmaceutical services rendered: the disease category or diagnosis. Recent literature is replete with articles and studies which examine disease-specific patterns of care and diagnosis related groups (DRG). Common denominators are standard patterns of medical care and similar resource utilization within diagnostic categories (Arbeit, et al., 1985, p. 235; Schroeder, 1980, p. 23; Miller, 1973, p. 557; Harding et al., 1985, p. 450; White, 1985, p. 146;

Knight, 1978, p. 275; Shapleigh, 1985, p. 2159; Mushlin, 1985, p.378). In fact, one can minimize the biased utilization introduced by DRGs by examining specific diagnoses for resource utilization.

If one examines this issue, however, as it relates to the prediction or containment of pharmacy costs, one discovers a great deal of variation in the utilization of ambulatory resources (Shroeder, 1980; White 1985; Shroeder et al., 1973 p. 969). Variations in physician-practice patterns lead us to believe that we can control our costs by controlling medications ordered for patients (Shapleigh, 1985, p. 2159).

VII. RESEARCH METHODOLOGY.

a. Using the Ambulatory Care Data Base (ACDB), randomly selected hypertensive patients treated in WACH during August 1986 through January 1987 will be listed by social security number. This list will then be given to the Chief, Outpatient Records Section of the Patient Administration Division for identification and isolation of the patients' medical records for audit. A pre-survey of the CY 1986 ACDB indicated that this six month period would provide an adequate population base to select a minimum sample size of 128 records. This sample size represents the minimum number of records required to conduct subsequent multiple regression and statistical analyses based on the demographic variables and control factors age, weight, sex, race, type of

practitioner, location, and presence of other diseases. This sample size would also represent approximately one percent of the patients treated during the audit period. Tnis appears to be consistent with other studies found in the medical literature.

b. The medical records will be audited for the clinical indicators of systolic blood pressure (SYS), diastolic blood pressure (DIAS), blood plasma level (K) and plasma uric acid (UA) level. These data, along with the demographic variables and control factors (age, sex, race, type of practitioner, presence of other diseases, location) will be collected. These data will be collected with regard to the patient's initial treatment for hypertension in order to effectively analyze the non-habitual prescribing patterns of the WACH practitioners.
The annual pharmaceutical cost will be calculated as follows: daily usage x 365 x average FY86 cost per unit (See Appendix A). A data base will be developed utilizing a computer data base management system.

c. A medication complexity index will be developed and utilized to standardize the measurement of the potential use of more complex medications in more complex hypertension patients. This index must take into consideration the two basic parameters of prescribed medications: the type of medication and the dosage of that medication. This will ensure that more complex medications prescribed at higher dosages are rated higher than less complex medications prescribed at lower dosages. This topic will be addressed in greater detail later in this text.

d. A practitioner index will be developed and utilized to standardize the measurement of type of practitioner along a scale of scope of practice. Using this type of index, practitioners with restricted scopes of practice would be rated lower than those with a broad scope of practice.

e. A multiple regression analysis will be conducted using the exogenous variables systolic blood pressure (SYS) diastolic blood pressure (DIAS), plasma potassium level (K), plasma uric acid level (UA), age (AGE), weight (WT), race (R), sex (S), presence of other diseases (D), type of practitioner (P) and medication complexity (MEDC) on annual pharmaceutical cost (COST). This analysis will yield beta values for each exogenous variable. Then the alternate hypothesis, $H_A : B = 0$, will be tested using the student t-test. This statistical test standardizes the mean of the sample to the mean of the hypothesized population mean, in this case $m = 0$. If the t-statistic is significantly different from zero for any exogenous variable, then a decision will be made in favor of the null hypothesis, $H_0 : B \neq 0$.

f. The correlation and variance for each exogenous variable and for the entire regression formula will be calculated to determine the degree to which the specific study variables explain the variation in annual pharmaceutical cost. If the correlation factor is high, then the specific study variables chosen can be said to be <u>good</u> predictors of annual pharmaceutical cost. One could then examine the applicability, if any, of cost containment programs.

From this perspective, a prediction model that relates diagnostic complexity to pharmacy cost could be of great benefit to hospitals interested in cost containment programs. Most health care purchasers, particularly third party buyers, would accept higher costs associated with increased case complexity. This is evidenced by the present DRG reimbursement system utilized by the US government in its MEDICARE program along with a number of large insurance corporations. One would be led to believe that if the variables which comprise diagnostic complexity are highly correlated to the annual pharmacy cost, then practitioners are prescribing effectively from a resource utilization, and therefore, a cost containment basis. This type of utilization review methodology could potentially reduce or eliminate the variance in prescribing patterns for specific diagnoses and similar clinical indications which could result in containment of, or at least predictability of, pharmacy pharmaceutical budget requirements based on known epidemiological patterns.

CHAPTER II

I. INTRODUCTION.

This chapter will first discuss the medication complexity index. This index was utilized in subsequent analyses. Next, the characteristics of Womack Army Community Hospital (WACH) and of the sample will be reviewed and analyzed. Finally, multiple linear regression and analysis of variance will be performed on the data against annual pharmaceutical COST (COST) and on medical complexity (MEDC). These results will then be graphically displayed and applied to the proposed patient-practitioner interaction model suggested previously (see Illustration 1).

II. MEDICATION COMPLEXITY INDEX.

The complexity of hypertension was previously discussed as related to clinical indicators, demographic variables and certain control factors. As diagnostic complexity increases, one would expect the use of more complex medications. The medication complexity index was developed to provide a basis from which to directly measure and compare the complexity of the disease process with the complexity of treatment.

In order to adequately measure the complexity of treatment, this medication complexity index must consist of two basic parameters: the choice of medication and the dosage of that medication. The first parameter, medication choice, was measured by comparing each medication to the classification of drug choices by the Joint National Committees of 1977 and 1980 (Kaplan, 1986, pp 180-263) and yielded Table 1.

Table1

Classification of Medications by Degree of Complexity

Index Value	Medication Category
4	all others
3	potassium-sparing agents
2	other diuretics
1	thiazides

While there are many other categories of drugs than those utilized, the sample size limited their classification to four categories. Thiazides included hydrochlorothizide and chlorothiazide and were considered the most basic diuretics. Other diuretics consisted of furosemides and sulfonamides and were considered slightly more complex than thiazides. Potassium-sparing agents included sprinolactone (and/or combinations) and triamterene (and/or combinations). These agents were considered more complex due to their potassium secretion inhibition or aldosterone antagonism effects. All other agents included a wide range of complex medications ranging from peripheral-acting adrenergic antagonists, central-acting alpha -agonists, alpha-adrenergic blockers, beta-adrenergic blockers, combined alpha- and beta-adrenergic blockers, vasodilators, slow channel calcium-entry blocking agents and angiotension-converting enzyme inhibitors. The values given to each medication, therefore, would range from 1 to 4 depending on the classification of the medication.

Using this methodology, for example, Dyazide (a combination hydrochlorothiazide and triamterene) would be given a medication category index value (MED) of three (3). Potassium (K) supplements were given a medication complexity value of one (1) because non-potassium depleting diuretics could be used in

conjunction with these supplements and still yield a medication complexity index of three (3) as are the potassium-sparing diuretics. For example:

Other diuretics	MED1 = 2	DOSI = 1
K Supplement	MED2 = 1	DOS2 = 1

MEDC = (2X1) + (1X1)

= 2 + 1

= 3* *Equivalent to category index value 3 for potassium-sparing diuretics

The second parameter, dosage (DOS) was calculated based on the daily dosage prescribed by the practitioners. The range of values for dosage was one every three days (.33) to three times daily (3). Using this methodology, for example, Dyazide twice daily would be given a dosage index value (DOS) of two (2). Combining the two parameters yielded the matrix as found in Table 2.

Table 2

Medication Complexity Matrix

Category					
4					
3					
2					
1					
Daily Dosage	.33	.50	1	2	3

Medication Complexity = Medication Category X Dosage

The medication complexity index was then calculated by multiplying the medication category index value (MED) times the dosage index value (DOS).

$$MEDC = MED \times DOS$$

This procedure was performed for each medication prescribed, (in some cases multiple medications were prescribed). The final transformation equation to develop the medication complexity index was:

$$MED\ C = (MED1 \times DOS1) + (MED2 \times DOS2) + (MED3 \times DOS3)$$

Using this transformation technique, for example, Dyazide twice daily and Inderal 40 mg three times daily would yield the following medication complexity index:

Dyazide: MED1 = 3 ; DOS1 = 2

Inderal 40 mg: MED2 = 4 ; DOS2 = 3

$$MEDC = (3X2) + (4X3)$$
$$= 6 + 12$$
$$= 18$$

Indices were adjusted for identical medications of varying strength. For example, if Inderal 20 mg twice daily were prescribed for one patient and Inderal 40 mg twice daily for another, the adjustments were accomplished as follows:

Inderal 40 mg: MED1 = 4 ; DOS1 = 2

$$MEDC = (4 \times 2)$$
$$= 8$$

Inderal 20 mg twice daily is equivalent to Inderal 40 mg once daily, therefore:

Inderal 20 mg: MED1 = 4 ; DOS1 = 1

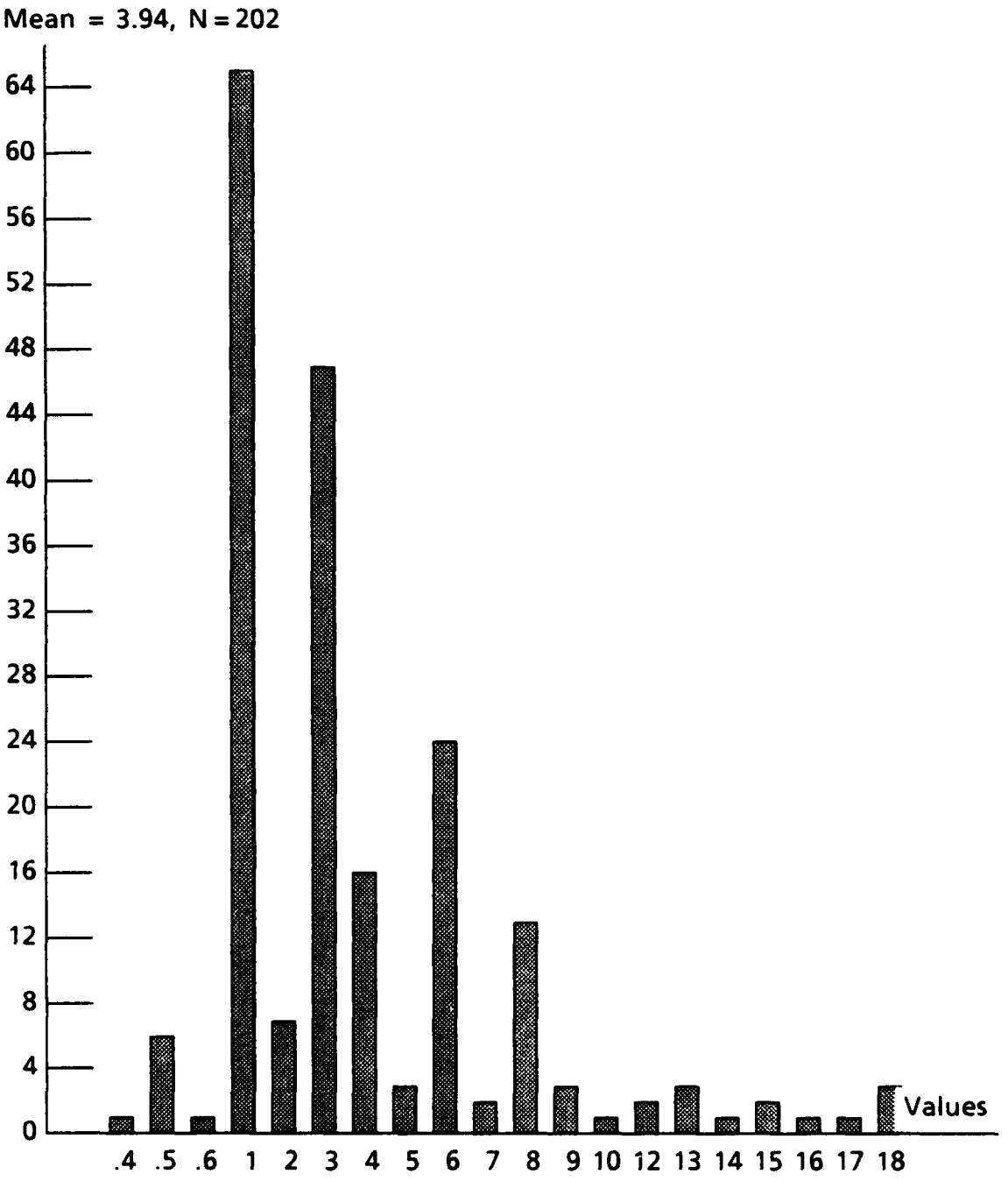
MEDC = (4 X 1)

= 4

Medications prescribed at a higher dosage on a strength adjusted basis, therefore, continued to receive a higher medication complexity index value. Medication complexity index values (MEDC) ranged from .4 to 18 and were distributed as illustrated in Table 3.

Table 3

Frequency Distribution of Medication Complexity Values



III. CHARACTERISTICS OF WOMACK ARMY COMMUNITY HOSPITAL.

Womack Army Community Hospital (WACH) is a general medical fixed treatment facility located at Fort Bragg, North Carolina. WACH supports a health service area consisting of the state of North Carolina and a beneficiary population estimated at 200,000 people consisting of active duty and retired personnel and their dependents. Built on a 500 bed chassis in 1956, WACH currently operates 288 beds and 31 bassinets. The average daily census is 200. During fiscal year 1986, WACH admitted 15,073 patients to the hospital, delivered 1,939 babies, and accumulated a total of 72,620 occupied bed days. Ambulatory care consisted of 852,751 clinic visits during the same period for an average of 2,336 visits daily. The total operating expenses, including military salaries, amounted to $76.97 million. The WACH Operations and Maintenance Army (OMA) budget totaled $28.5 million, while the WACH health service area generated in excess of $26 million in CHAMPUS claims. The WACH pharmacy budget was in excess of $4.5 million with anti-hypertensive agents alone costing over $630 thousand.

IV. CHARACTERISTICS OF THE SAMPLE.

During the audit period, 1336 medical records were audited for initial treatment of hypertension. This resulted in a total hypertensive sample of 202 (15%). The sample included 67 male (33.2%) and 135 female (66.8%); 123 white (60.9%); 68 black (33.7%); asian (4.4%); and 2 hispanic (1%) patients. A sex by race matrix is found in Table 4. Age ranged from a low of 24 years to a high of 75 years, with the largest number of patients, 78 (38.61%) falling into the 41-50 age group as found in Table 5. Weight was found to range from a low of 100 pounds to a high of 302 pounds, with the largest number of patients, 102 (50.75%) falling into the 151-200 pound weight group as shown in Table 6.

The study population was also examined with regard to the type of practitioner who initiated therapy and the location within the delivery system where treatment was initiated.

Table 4

Sex by Race Matrix

	Black	White	Hispanic	Asian	Total
Female	47	77	2	9	135
Male	21	46	0	0	67
Total	68	123	2	9	202

Table 5

Frequency Distribution of Age

Age	Frequency	Percentage	Cumulative Percentage
21-30	8	3.96	3.96
31-40	32	15.84	19.80
41-50	78	38.61	58.41
51-60	64	31.68	90.09
61-70	15	7.43	97.52
71 +	5	2.48	100

Table 6

Frequency Distribution of Weight

Weight	Frequency	Percentage	Cumulative Percentage
50-100	1	00.00	00.00
101-150	56	27.86	27.86
151-200	102	50.75	78.61
201-250	38	18.90	97.51
251 +	5	2.49	100

The practitioner index was a measurement methodology utilized to classify the type of practitioner along a scale of increasing scope of medical practice. The staff physician (MD) in this group had the broadest scope of practice and for purposes of this study, had no restrictions, and were classified level 4. The Family Practice Residents (RES) have graduated from medical schools but were in various phases of an Army residency program in family medicine. Although fully qualified physicians, they were closely supervised during their residency program by team leaders, the residency program director, and the department chief. In this regard, their scope of practice was considered to be less than that of a staff physician, and therefore, were classified level 3. The Physician Assistant has been defined as a health care extender, who practices medicine within the scope of practice as outlined in the Army Regulation (AR) 40-48. Their scope of practice has been restricted and they must operate under the direct supervision of a physician. From this perspective, their scope of practice and therefore, their practitioner index, would be less than that of a staff physician or a resident (physician). They were categorized level 2. The Nurse Practitioner (NP) has been defined as a health care extender, who practices medicine within the scope of practice in accordance with Army Regulation (AR) 40-48. Their scope of practice is very restricted and they must operate under the direct supervision of a physician. Nurse practitioners have generally been given authority to practice medicine within a specific specialty such as pediatrics, hypertension, etc. As a result, their scope of

practice would be less than that of a staff physician, resident (also a physician) or physician assistant (PA). Therefore, as a group, they received the lowest practitioner index, level 1.

The frequency distribution of the number of patients treated by type of practitioner is illustrated in Table 7. The largest number of patients, 110 (45.45%), were treated by staff physicians.

An analysis of variance by type of practitioner was performed on these data. The summary of these results can be found in Table 8. The results suggest that physician assistants (PA) prescribed medication on a complexity level not exceeded even by staff physicians at WACH, 4.4 and 4.5 respectively, $F=2.843$, $p \leq .03$.

Table 7

Frequency Distribution by Type of Practitioner

Type of Practitioner	Practitioner Index *	Frequency	Percentage	Cumulative Percentage
Staff Physician (MD)	4	110	54.45	54.45
Resident (Res)	3	31	15.35	69.80
Physician Assistant (PA)	2	31	15.35	85.15
Nurse Practitioner (NP)	1	30	14.85	100

*Ordinal value determined by scope of practice

Table 8

Analysis of Variance by Type of Practitioner

Type of Practitioner	MEDC	AGE
MD (4)	4.40*	47.19
RES (3)	2.48	48.32
PA (2)	4.50*	49.07
NP (4)	3.18	52.93**

*F = 2.843, P$\leq$ .03 **F = 2.846, P$\leq$ .03

This is certainly an interesting finding, and may be a clear representation of either the expected role of PAs, the perception of their role, or a combination of both. The restricted scope of practice addressed in AR 40-48 and the potential formulary restrictions during the study period did not appear to mask or confound this effect. The results also seem to indicate that on the average, Nurse Practitioners (NP) were found to interact more with an older patient than the other types of practitioners, 52.93, $F=2.846$, $p \leq .03$. A consideration that location may have confounded these results was explored since specific types of practitioners tend to be found at certain locations within the treatment facility. A matrix of type of practitioner by location is found at Table 9.

The frequency distribution of patients by location is found in Table 10. The greatest number of patients were treated in the Acute Minor Illness Clinic (AMIC), 76 (37.81%), and the Medical Clinic (MEDCL), 75 (37.31%).

An analysis of variance by location was performed on these data with the summary results found in Table 11. With regard to systolic blood pressure (SYS), the Emergency Room was found to have treated patients with significantly higher mean systolic blood pressure, 181.4 mm mercury (Hg), $F=6.804$, $p<.001$, than the other locations. This would be expected since the Emergency Room would have received a higher proportion of hypertensive crisis patients, who are considered to be medical emergencies.

Table 9

Type of Practitioner by Location Matrix

	AMIC	ER	FP	MEDCL	TOTAL
MD (4)	50	11	6	42	109
RES (3)	0	0	30	1	31
PA (2)	26	3	0	2	31
NP (1)	0	0	0	30	30
TOTAL	76	14	36	75	201

*1 TMC record deleted.

Table 10

Frequency Distribution by Location

Location	Frequency	Percentage	Cumulative Percentage
Acute Minor Illness Clinic (AMIC)	76	37.81	37.81
Emergency Room (ER)	14	6.97	44.78
Family Practice Clinic (FP)	36	17.91	62.69
Medical Clinic (MEDCL)	75	37.31	100
Troop Medical Clinic (TMC)	1	00.00	100

Table 11

Analysis of Variance by Location

	SYS	D	P
AMIC	160.2	1.24	3.32
ER	181.4*	1.42**	3.57***
FP	152.7	1.28	3.17
MEDCL	160.0	1.44**	2.73

*F = 6.804, $p < .001$
**F = 2.756, $p \leq .04$
***F = 4.587, $p \leq .004$

n = 201

The AMIC and MEDCL were found to have treated patients with approximately the same mean systolic blood pressure, 160.2 versus 160.0 mm Hg, while the Family Practice Clinic, on the average, treated patients with lower mean SYS, 152.7 mm Hg. The Emergency Room (ER) and MEDCL were also found to have significantly higher (and approximately equal) mean disease index, 1.42 and 1.44, $F=2.756$, $p \leq .04$, versus 1.24 and 1.28 in the AMIC and Family Practice Clinics (FP) respectively.

The disease index was a measurement methodology utilized to classify patients along a scale with regard to the presence of certain other disease processes that would increase the diagnostic complexity of the patient. The disease processes that were classified "yes" included all documented cardiovascular disease (to remove some potential confounding effects without actually measuring cholesterol or triglyceride levels), renal disease (to remove some potential confounding effects of renin-angiotensin without actually measuring sodium electrolyte levels), and pancreatic disease (to remove potential confounding effects of diabetes mellitus without actually measuring glucose levels). The presence of other disease, within this rubric, would add to the diagnostic complexity of the hypertensive patient since these particular diseases have been found to be associated with higher risk and/or morbidity with regard to hypertension (Kaplan, 1986). Thus, the categorized data, yes and no, were transformed into ordinal data using the scale 1 (no other disease present) to 2 (presence of other disease). The higher index value would, therefore, represent a greater degree of disease.

The ER and AMIC would be expected to see more complex disease processes by virtue of the type of patient that would be seen at that location. Although the accessibility of patients to these locations changes over time by means of standard operating procedures (SOP), as well as clinic, department, and command policies, the most complex disease processes appear to be gaining access to the appropriate locations. While this may appear to present a positive finding from a quality assurance view, data was not available in this study to verify this finding since access to care must contain not only a quality, but also a quantity dimension.

With respect to the type of practitioner, the ER was found to have treated patients with a significantly higher practitioner index value, 3.57, $F=4.587$, $p \leq .004$; followed by the AMIC, 3.32, the FP Clinic, 3.17; and the MEDCL, 2.73. While this confirms the presence of certain types of practitioners in certain locations in the treatment facility, the inconsistency of practitioner type to medication complexity (MEDC) certainly warrants further investigation. This issue will be addressed later in this text. Most noteworthy, however, is that there was no significant difference in COST based on type of practitioner or on location.

An analysis of variance by race (R) and sex (S) was then performed on the data. Hispanic and Asian patient records were deleted prior to this analysis because they consisted only of females, male = 0. This adjusted sex by race matrix is found in Table 12.

Table 12

Adjusted Race by Sex Matrix

	Male (1)	Female (2)	Total
White (l)	46	77	123
Black (2)	21	47	68
Total	67	124	191*

* 11 Hispanic and Asian removed, M = 0

The remaining patient records were classified using a race index which was a measurement methodology utilized to classify patients along a scale of race, increasing from white to black. Thus, the categorical data, white and black, were transformed into ordinal data using the scale 1 (white/non-black) to 2 (black). The higher race index would, therefore, represent a higher degree of blackness. A similar measurement methodology was utilized to classify patients along a scale of sex, by transforming the categorical data male and female to ordinal data using the scale 1 (male/non-female) to 2 (female). The higher sex index value would, therefore, represent a greater degree of femaleness.

Review of those initial results, illustrated in Tables 13 to 16 indicated significant relationships between race (R) and systolic BP (SYS): white patients were found to have significantly higher systolic BP (SYS), 162.46 mm Hg, $F=3.765$, $p \leq .05$; sex (S) and uric acid (UA): male patients were found to have significantly higher mean plasma uric acid (UA) levels, 6.61 mg percent, $F=18.67$, $p \leq .001$; sex (S) and weight (WT): male patients were found to have significantly greater mean weight, 195.25 pounds, $F=18.758$, $p \leq .001$. Differences in systolic blood pressure by race are well documented in the medical literature. However, other studies have found that blacks tend to have higher blood pressures (Kaplan, 1986, p.5). Many factors could have contributed to this difference, such as diet, personal habits and age. The mean age of the white patients in this sample was significantly higher than the black patients, 50.62* versus 45.16 years, $*F=11.45$, $p \leq .001$. Increased blood pressure with age is

well documented in the medical literature (Kaplan, 1986, pp 19-22). Blood pressure, particularly systolic, has been found to increase progressively with age. A five (5) year mean difference in age could certainly account for a majority of difference in systolic BP (SYS) given these age groups.

The relationship between sex (S) and uric acid (UA) must be addressed from two perspectives. First, the medical literature has been found to be replete with documentation on the relationship between hypertension and hyperuricemia and gout (Kaplan, 1986, pp 44, 198-199). Hypertension has demonstrated to be more common in patients with gout (possible renal involvement) and hyperuricemia has been found in as many as 25 to 50 percent of untreated hypertension patients. Second, the clinical chemistry literature has documented different normal ranges for plasma uric acid levels for males and females (Teitz, 1985, p. 1225). The normal expected range for males was found to be 3.5 to 7.2 mg per 100 ml, and 2.6 to 6.0 mg per 100 ml for females. This sample demonstrated 81 (40.1%) hyperuricemic patients: 24 of 67 males (35.82%) and 57 of 135 females (42.22%). A significant difference in mean serum uric acid (UA) level was found between the male and female patients, 6.607* versus 5.661 mg percent, respectively, *t=4.267, $p \leq .001$.

A chi square test was performed on the data to determine whether there was a significant difference in hyperuricemic patients in the male (35.22%) and female (42.22%) groups. No significant difference (alpha = .05) was found, $X_{(1)}^2 = .52$, $p \leq .47$. Therefore, the relationship of uric acid to sex appeared to be

related to the difference in the normal range of values expected for differences in sex and not to differences in the number of hyperuricemic patients within each group.

The relationship between sex and weight was an expected finding given that males have traditionally been heavier than females. This finding appears to be self evident. Finally, a significant relationship was discovered between race and age, white patients were older than black patients, 50.62* versus 45.16 years, *F=11.45, $p \leq .001$ respectively. This finding was also interpreted to mean that black patients were being diagnosed at a significantly earlier age than whites. This could have been due to either clinical symptomology emerging at an earlier age or due to the closer examination of the black population by practitioners for hypertension as a result of the documentation of high prevalence and mortality data in the medical literature.

At the 90% confidence level (alpha = .10), several additional relationships began to emerge. At this level of confidence, relationships between sex (S) and potassium level (K) : males had significantly higher mean potassium levels (K), 4.24* versus 4.11 mg percent, *F=3.231, $p \leq .07$; and race (R) with medication complexity (MEDC): blacks having a significantly higher medication complexity index, 4.66* as compared to 3.34, *F=3.221, $p \leq .07$, were found. The relationship between sex (S) and potassium (K) was not an important clinical finding since the

mean value for males still fell within the normal range for male plasma potassium (K) levels. The significant relationship between race (R) and medication complexity (MEDC), however, could represent a significant clinical finding. The suggestion that black patients may have been screened at an earlier age by a practitioner has already been presented. I would also like to suggest that black patients may have been treated more aggressively, that is, more complex medication (either by category or dosage) was prescribed as a result of their being black. This could very well have been due to a predisposition of practitioners to look for more serious disease as a result of the medical literature, particularly since there was no apparent increased severity of disease. While the literature presents a higher mortality rate for blacks with hypertension (Kaplan, 1986, pp 16-17), there was no clear evidence that hypertension was the primary cause of the high mortality rate rather than a contributing factor to other disease processes. However, in either case, the significantly higher medication complexity index found was not associated with higher mean clinical indicators. Neither other demographic variables nor control factors appeared to have explained this finding.

Table 13

Analysis of Variance Race by Sex:
Systolic Blood Pressure

	Male (1)	Female (2)	Mean
White (1)	160.239	163.792	162.46*
Black (2)	153.476	157.447	156.22

*F = 3.765, $p \leq .05$
n = 191

Table 14

Analysis of Variance: Race by Sex:
Uric Acid

	Male (1)	Female (2)
White (1)	6.404	5.64
Black (2)	7.052	5.757
Mean	6.61*	5.68

*F = 18.67, $p < .001$
n = 191

Table 15

Analysis of Variance : Race by Sex: Weight

	Male (1)	Female (2)
White (1)	198.696	164.571
Black (2)	187.714	174.149
Mean	195.25*	168.20

*F = 18.758, $p < .001$
n = 121

Table 16

Analysis of Variance: Race by Sex: Age

	Male (1)	Female (2)	Mean
White (1)	52.11	49.73	50.62*
Black (2)	47.33	44.19	46.16

*F = 11.45, $p \leq .001$
n = 191

V. INITIAL REGRESSION/PEARSON CORRELATION RESULTS/DISCUSSION.

A multiple linear regression yielded a multiple R (correlation) of .822 and a square multiple R (variance) of .676 when medication complexity (MEDC), systolic BP (SYS), diastolic BP (DIAS), potassium (K), uric acid (UA), weight (WT), age (AGE), type of practitioner (P), sex (S) race (R), and presence of other diseases (D) were regressed on total annual pharmaceutical cost (COST). For purposes of review, each variable has been defined in Appendix B. These eleven (11) exogenous variables, therefore, explained 67.6% of the variance in COST of treatment for hypertension patients at WACH. However, only medication complexity (MEDC) was a statistically significant predictor of COST (alpha = .05) with a standardized beta value of .814, $t=18.24$, $p<.001$.

An analysis of variance of that data set yielded a significant F-ratio, $F=36.007$, $p<.001$, suggesting that this regression model is a good predictor of explained COST variance.

A stepwise regression was then conducted on the data using an 85 percent confidence interval (alpha = .15). A trade-off was accepted in this portion of the analysis in favor of less precision and greater flexibility since several key variables were related to human behavior and judgement. The step-wise

regression yielded two primary variables as predictors of COST: medical complexity (MEDC) and potassium (K), with R square of .66 and .006 respectively.

A reduced regression analysis was then performed on the data with the model

COST = constant + MEDC + K

and yielded a multiple R of .816 and a squared multiple R of .666. Both MEDC and K were statistically significant predictors of COST (alpha =.15) with standardized beta values of 0.813, t=19.83, $p<.001$ and 0.073, t=1.79, $p \leq .07$ respectively.

An analysis of variance performed on the new dataset yielded a significant F-ratio, F=197.995, $p<.001$, suggesting that this model would be a good predictor of explained COST variance. A summary of these results can be seen in Table 17.

Prior to graphically displaying data, the Pearson correlation matrix was reviewed and found to be -0.008 for MEDC and K. Therefore, since no shared variance was found, the two could be considered unrelated or independent. The fact that MEDC has shown to be highly correlated to COST and shares a large variance with COST validates the construct of that variable. However, 34 percent of the variance in COST remained unexplained. A graphic illustration of this relationship can be seen in Illustration 3.

Table 17

Regression Analysis of COST

DEP VAR: COST N: 202 MULTIPLE R: .822 SQUARED MULTIPLE R: .676

ADJUSTED R^2 = 1-(1-R^2)*(N-1)/DF, WHERE N= 202, AND DF= 190: .657

VARIABLE	COEFFICIENT	STD. ERROR	STD. COEF.	TOLERANCE	T	P(2 TAIL)
CONSTANT	45.895	58.886	0.000	.	.78	.437
MEDC	17.141	0.940	0.814	0.85659	18.24	.000
SYS	-0.193	0.195	-0.052	0.63364	-.99	.322
DIAS	-0.030	0.370	-0.004	0.60635	-.08	.935
K	9.166	6.081	0.064	0.95220	1.51	.133
UA	-2.650	2.264	-0.052	0.86178	-1.17	.243
WT	0.004	0.096	0.002	0.81716	.04	.967
AGE	-0.329	0.402	-0.041	0.68896	-.82	.414
P	-1.323	2.955	-0.019	0.93810	-.45	.655
S	-6.575	7.804	-0.039	0.77884	-.84	.401
R	-9.070	7.323	-0.055	0.87787	-1.24	.217
D	5.837	7.405	0.035	0.85866	.79	.432

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	841206.631	11	76473.330	36.007	.000
RESIDUAL	403529.136	190	2123.838		

STEPWISE REGRESSION WITH ALPHA-TO-ENTER= .150 AND ALPHA-TO-REMOVE= .150

STEP= 1 ENTER MEDC R= .813 RSQUARE= .660
STEP= 2 ENTER K R= .816 RSQUARE= .666

DEP VAR: COST N: 202 MULTIPLE R: .816 SQUARED MULTIPLE R: .666

ADJUSTED R^2 = 1-(1-R^2)*(N-1)/DF, WHERE N= 202, AND DF= 199: .662

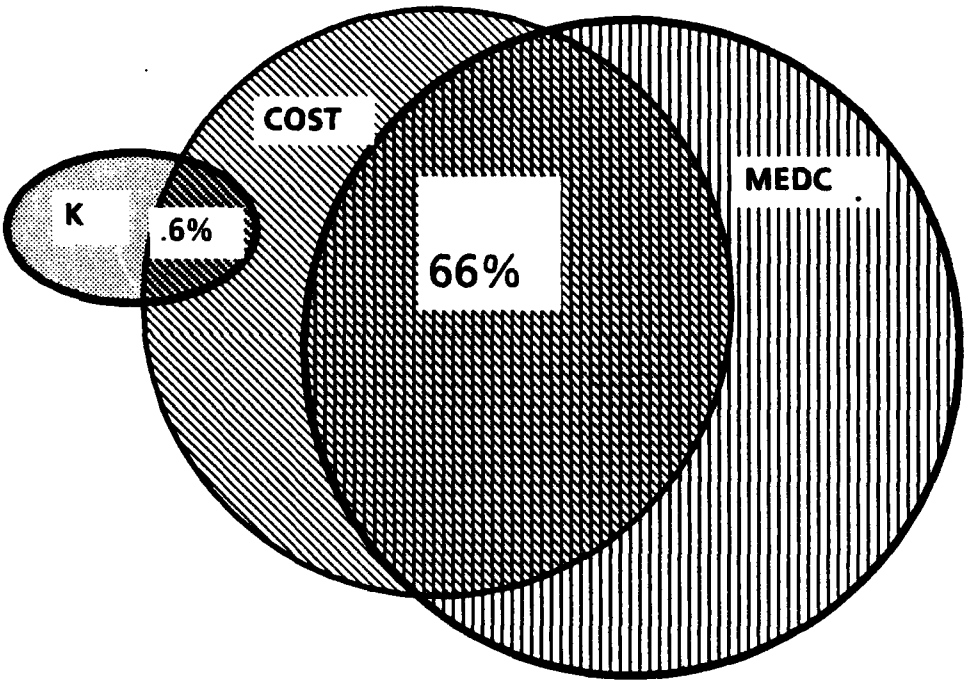
VARIABLE	COEFFICIENT	STD. ERROR	STD. COEF.	TOLERANCE	T	P(2 TAIL)
CONSTANT	-44.129	24.898	0.000	.	-1.77	.078
MEDC	17.122	0.863	0.813	0.99993	19.83	.000
K	10.529	5.889	0.073	0.99993	1.79	.075

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	828422.171	2	414211.085	197.995	.000
RESIDUAL	416313.597	199	2092.028		

Illustration 3

Relationship of MEDC and K to COST*



COST = -44.129 + 17.122 MEDC + 10.529 K

SHARED VARIANCE (R SQUARE)
MEDC X COST: 66.0%
K X COST : 0.6%

* Effects of all other variables removed

To explore possible explanations for this unexplained variance, a statistical analysis was performed on the data set by medication category of those patients with only one medication. A summary of these results is found in Table 18. The analysis of that data clearly illustrated the wide variation in dosages and costs within each category. For example, the minimum (1)* and maximum (3)** dosages in medication category 4 are both significantly different (alpha=.05) from the mean dosage (1.548), *t=-4.89, p<.001, and **t=12.95, p<.001, as are the minimum (0.73)* and maximum ($536.55)** COSTS from the mean COST (95.159), *t=-5.39, p<.001, and **t=25.21, p<.001; respectively. This appeared to be true with one exception: the minimum COST within medication category 3. The choice of medication category appeared to have a significant impact on the dosing, and therefore, medication complexity, as well as total annual cost (COST).

Table 18

DOS 1 and COST Statistics by Medication Category

Medication Category	Statistics	DOS 1	COST
4	n =	31	31
	Minimum	1 t = -4.89 p<.005	$0.73 t = -5.39 p < .005
	Maximum	3 t = 12.95 p < .005	$536.55 t = 25.21 p < .005
	Mean	1.548 t = 13.23 p < .005	$95.159 t = 12.30 p < .005
	Std Deviation	0.624	$97.501
3	n =	71	71
	Minimum	1 t = -5.89 p<.005	$7.30 t = -20.80 p < .005
	Maximum	2 t = 11.72 p < .005	$146.00 t = 11.46 p < .005
	Mean	1.338 t = 5.01 p < .005	$96.708 t = 12.77 p < .005
	Std Deviation	0.476	$36.228

Table 18 (Continued)

DOS 1 and COST Statistics by Medication Category

Medication Category	Statistics	DOS 1	COST
2	n =	7	7
	Minimum	0.2 t = -3.34 p < .01	$ 1.83 t = -1.73
	Maximum	1 t = 2.69 p < .025	$54.75 t = 3.86 p < .005
	Mean	0.643 t = -22.21 p < .005	$18.176 t = -11.49 p < .005
	Std Deviation	0.351	$25.052
1	n =	72	72
	Minimum	0.5 t = -16.84 p < .005	$ 0.55 t = -16.97 p < .005
	Maximum	2 t = 33.67 p < .005	$2.19 t = 33.63 p < .005
	Mean	1 t = -8.22 p < .005	$1.10 t = -16.77 p < .005
	Std Deviation	0.252	$0.275

Potassium (K), interestingly, began to emerge as a significant predictor of COST (alpha = .15). Unfortunately, K only explained 0.6 percent of the variance in COST. Since K demonstrated a positive coefficient (beta = 9.166), COST would increase with increasing plasma K levels. This relationship appeared reversed, given that diagnostic complexity would be expected to increase as plasma K levels fell below 3.5 mg percent. An increase in diagnostic complexity would then be expected to increase medication complexity and have a corresponding increase in COST. This topic will be further explored later.

Based on these results, the exogenous variable medication complexity (MEDC) was removed from the regression analysis and the remaining exogenous variables, SYS, DIAS, K, UA, WT, AGE, P, S, R, and D, were regressed on COST. With the effects of the largest non-clinical predictor of COST removed, the relationship of the clinical and demographic variables were further explored. When regressed on COST, the ten (10) exogenous variables yielded a multiple R of .329 and a squared multiple R of .108. Thus, these variables explained 10.8% of the variance of COST when the effects of medication complexity (MEDC) were removed. Presence of other diseases (D) and uric acid (UA) were found to be statistically significant predictors of COST (alpha = .05) with standardized beta values of 0.245 ($t=3.45$, $p \leq .001$) and -0.140 ($t=-1.91$, $p \leq .05$).

An analysis of variance of this regression model yielded an F ratio of F=2.317, $p \leq .014$, verifying that this regression model significantly explained variance in COST.

A stepwise regression was then performed (alpha = .15) and yielded:

	MULTIPLE R	MULTIPLE R SQUARE
D:	0.258	0.0666
UA:	-0.121	0.0146

suggesting that the presence of other diseases (D) explained 6.66% of the variance in COST with uric acid (UA) incrementally explaining 1.46% of that variance.

When a reduced regression model

$$COST = constant + D + UA$$

was utilized, a multiple R of .288 and a square multiple R of .083 was found. The standardized beta values for these significant predictors of COST (alpha = .15) were estimated to be 0.262 (t=3.85, $p < .001$) for D; and -0.129, (t= -1.89, $p \leq .06$) for UA. Thus, the final prediction formula for COST without the effects of MEDC or the other removed exogenous variables, was:

$$COST = 48.01 + 43.467\ D - 6.544\ UA$$

The results of these analyses are depicted in Table 19.

Table 19

Regression Analysis of COST, MEDC Removed

DEPENDENT VARIABLE: COST

N: 202 MULTIPLE R: .329 SQUARED MULTIPLE R: .108

$ADJUSTED\ R^2 = 1-(1-R^2)*(N-1)/DF$, WHERE N= 202, AND DF= 191: .061

VARIABLE	COEFFICIENT	STD. ERROR	STD. COEF.	TOLERANCE	T	P(2 TAIL)
CONSTANT	1.436	97.329	0.000	.	.01	.988
SYS	-0.024	0.322	-0.006	0.63509	-.07	.941
DIAS	0.452	0.610	0.065	0.60946	.74	.460
K	10.448	10.058	0.073	0.95233	1.04	.300
UA	-7.122	3.723	-0.140	0.87201	-1.91	.057
WT	-0.140	0.159	-0.066	0.82268	-.88	.379
AGE	-0.207	0.665	-0.026	0.68915	-.31	.756
P	2.509	4.877	0.036	0.94286	.51	.607
S	-13.457	12.894	-0.081	0.78067	-1.04	.298
R	14.047	11.932	0.085	0.90497	1.18	.241
D	40.780	11.833	0.245	0.92026	3.45	.001

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	134639.854	10	13463.985	2.317	.014
RESIDUAL	1110095.914	191	5812.020		

STEPWISE REGRESSION WITH ALPHA-TO-ENTER= .150 AND ALPHA-TO-REMOVE= .150

STEP= 1 ENTER D R= .258 RSQUARE= .067
STEP= 2 ENTER UA R= .288 RSQUARE= .083

DEP VAR: COST N: 202 MULTIPLE R: .288 SQUARED MULTIPLE R: .083

$ADJUSTED\ R^2 = 1-(1-R^2)*(N-1)/DF$, WHERE N= 202, AND DF= 199: .074

VARIABLE	COEFFICIENT	STD. ERROR	STD. COEF.	TOLERANCE	T	P(2 TAIL)
CONSTANT	48.010	25.760	0.000	.	1.86	.064
D	43.467	11.281	0.262	0.99914	3.85	.000
UA	-6.544	3.455	-0.129	0.99914	-1.89	.060

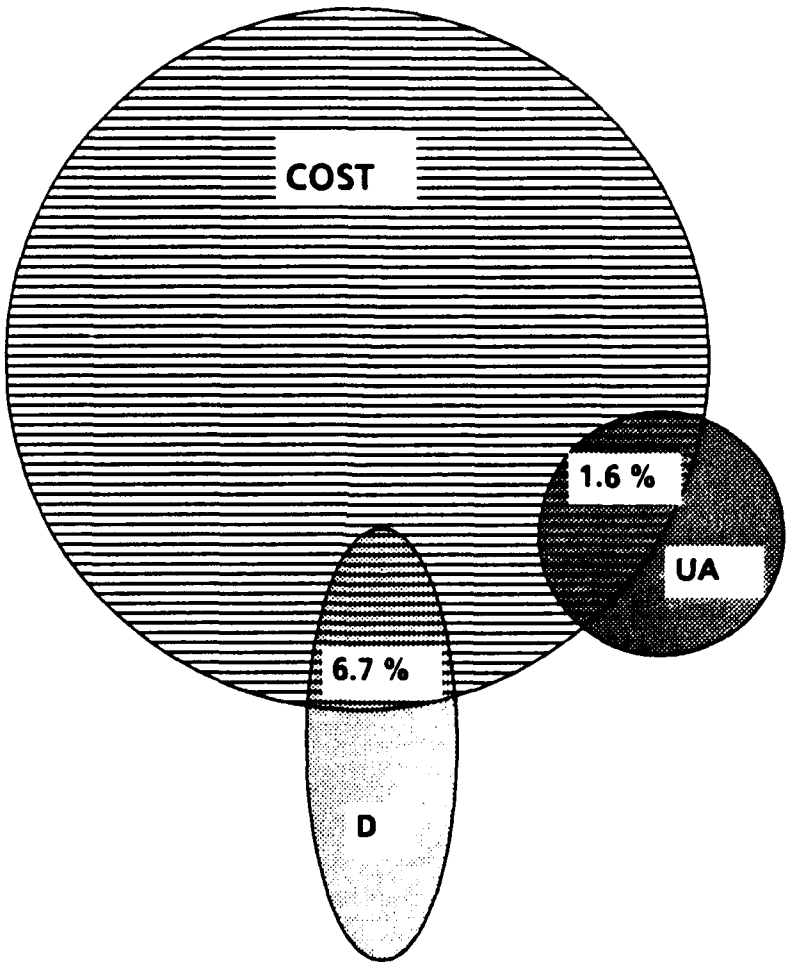
ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	103368.168	2	51684.084	9.011	.000
RESIDUAL	1141367.600	199	5735.516		

Prior to graphically depicting these results, the Pearson correlation matrix was reviewed to find potential interaction effects. No interaction of COST predictor variables was found. Other interactions found were diastolic BP (DIAS) with age (AGE), DIAS X AGE : 6.6%; Diastolic BP (DIAS) with presence of other diseases (D) DIAS X D : 2.28%; diastolic BP (DIAS) with systolic BP (SYS), DIAS X SYS : 24.70%; presence of other diseases (D) and systolic BP (SYS), D X SYS : 2.92%; presence of other diseases (D) and age (AGE), D X AGE : 2.59%; uric acid (UA) and weight (WT), UA X WT : 7.45%; and uric acid (UA) and sex (S), UA X S : 8.35%. However, since these interactions did not directly relate to the endogenous variable COST, they were not further explored in this portion of the analysis. A graphic depiction of these results is found in Illustration 4.

Illustration 4

Relationship of D and UA to COST*



COST = 48.01 + 43.467 D - 6.544 UA

SHARED VARIANCE
D X COST: 6.66%
UA X COST: 1.64%

*Effects of medication complexity (MEDC) and all other exogenous variables removed.

A multiple linear regression analysis yielded a multiple of R of .379 and a square multiple R of .143 when systolic BP (SYS), diastolic BP (DIAS), potassium (K), uric acid (UA), weight (WT), age (AGE), type of practitioner (P), sex (S), race (R), and the presence of other diseases (D), were regressed on medication complexity (MEDC). These ten (10) exogenous variables were found to explain 14.3% of the variation in medication complexity (MEDC). However, only race (R) and the presence of other diseases (D) were found to be significant predictors of MEDC (alpha = .05) with standardized beta values of 0.171 ($t=2.43$, $p \leq .01$) and 0.258 ($t=3.70$, $p<.001$) respectively.

An analysis of variance of this regression model yielded an F-ratio of $F=3.198$, $p \leq .001$, indicating that this regression model significantly predicted medication complexity variance.

A stepwise regression was conducted (alpha = .15) and yielded:

	MULTIPLE R	MULTIPLE R SQUARE
D	0.287	.082
R	0.321	0.103
UA	0.342	0.117
DIAS	0.360	0.129

These four (4) exogenous variables explained 12.9% of the variance in medication complexity (MEDC), with the presence of other diseases (D) accounting for 8.2% of that variance and race (R), uric acid (UA) and diastolic BP (DIAS) incrementally explaining 2.1%, 1.4% and 1.2% respectively.

A reduced regression model of these four (4) exogenous variables was then utilized,

MEDC = Constant + D + R + UA = DIAS

and yielded a multiple R of .360 and a squared multiple R of .129. The standardized beta values for these significant predictors of medication complexity (MEDC) (alpha = .15) were estimated to be: DIAS, 0.113 (t=1.68, $p \leq .09$); UA, -0.114 (t=-1.70, $p \leq .09$); R, 0.152 (t=2.28, $p \leq .02$); and D, 0.276 (t=4.10, $p \leq .001$). A summary of these results is found in Table 20.

Table 20

Regession Analysis of MEDC

DEP VAR: MEDC N: 202 MULTIPLE R: .379 SQUARED MULTIPLE R: .143

ADJUSTED R^2 = 1-(1-R^2)*(N-1)/DF, WHERE N= 202, AND DF= 191: .099

VARIABLE	COEFFICIENT	STD. ERROR	STD. COEF.	TOLERANCE	T	P(2 TAIL)
CONSTANT	-2.594	4.530	0.000	.	-.57	.56
SYS	0.010	0.015	0.055	0.63509	.66	.51
DIAS	0.028	0.028	0.085	0.60946	.99	.32
K	0.075	0.468	0.011	0.95233	.16	.87
UA	-0.261	0.173	-0.108	0.87201	-1.51	.13
WT	-0.008	0.007	-0.084	0.82268	-1.14	.25
AGE	0.007	0.031	0.019	0.68915	.23	.81
P	0.224	0.227	0.068	0.94286	.99	.32
S	-0.401	0.600	-0.051	0.78067	-.67	.50
R	1.349	0.555	0.171	0.90497	2.43	.01
D	2.039	0.551	0.258	0.92026	3.70	.00

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	402.585	10	40.259	3.198	.001
RESIDUAL	2404.722	191	12.590		

STEPWISE REGRESSION WITH ALPHA-TO-ENTER= .150 AND ALPHA-TO-REMOVE= .150

STEP= 1	ENTER D	R= .287	RSQUARE= .082	
STEP= 2	ENTER R	R= .321	RSQUARE= .103	
STEP= 3	ENTER UA	R= .342	RSQUARE= .117	
STEP= 4	ENTER DIAS	R= .360	RSQUARE= .129	

N: 202 MULTIPLE R: .360 SQUARED MULTIPLE R: .129

ADJUSTED R^2 = 1-(1-R^2)*(N-1)/DF, WHERE N= 202, AND DF= 197: .112

VARIABLE	COEFFICIENT	STD. ERROR	STD. COEF.	TOLERANCE	T	P(2 TAIL)
CONSTANT	-2.639	2.532	0.000	.	-1.04	.29
DIAS	0.037	0.022	0.113	0.97443	1.68	.09
UA	-0.275	0.161	-0.114	0.98931	-1.70	.09
R	1.203	0.526	0.152	0.99228	2.28	.02
D	2.177	0.531	0.276	0.97520	4.10	.00

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	363.374	4	90.844	7.323	.000
RESIDUAL	2443.933	197	12.406		

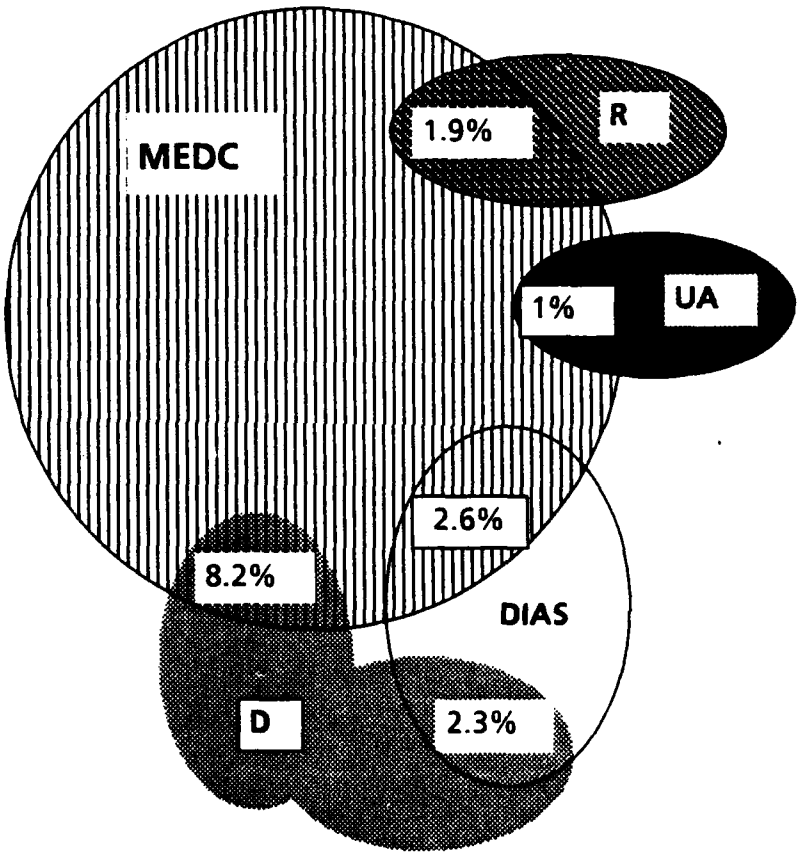
An analysis of variance of this regression model yields a significant F-ratio, $F = 7.323$, $p<.001$, indicating that these variables were significant predictors of MEDC variance. A summary of these results can be found in Table 20. Thus, the final prediction formula for MEDC was:

$$MEDC = -2.639 + 0.037\ DIAS - 0.275\ UA + 1.203\ R + 21.77\ D$$

Prior to graphically depicting these results, the Pearson correlation table was reviewed to identify potential interaction effects. A small interaction between diastolic BP (DIAS) and presence of other diseases (D), DIAS X D : 2.28%, was the only interaction effect found among the MEDC predictor variables. However, interactions between DIAS and SYS: 24.70%; DIAS X AGE : 6.6%; D X SYS : 2.02%; D X AGE : 2.59%; UA X WT : 7.45%; UA X SEX : 8.35%; R X SYS : 1.88%; R X K : 1.61%; and R X AGE : 6.0% were also seen. Since these other interactions did not contribute directly to the endogenous variable MEDC, they were not further addressed in this portion of the analysis. A graphic depiction is found at Illustration 5.

Illustration 5

Relationship of D, DIAS, R, and UA to MEDC*



MEDC = -2.639 + .037 DIAS - .275 UA + 1.203 R + 2.177

SHARED VARIANCE

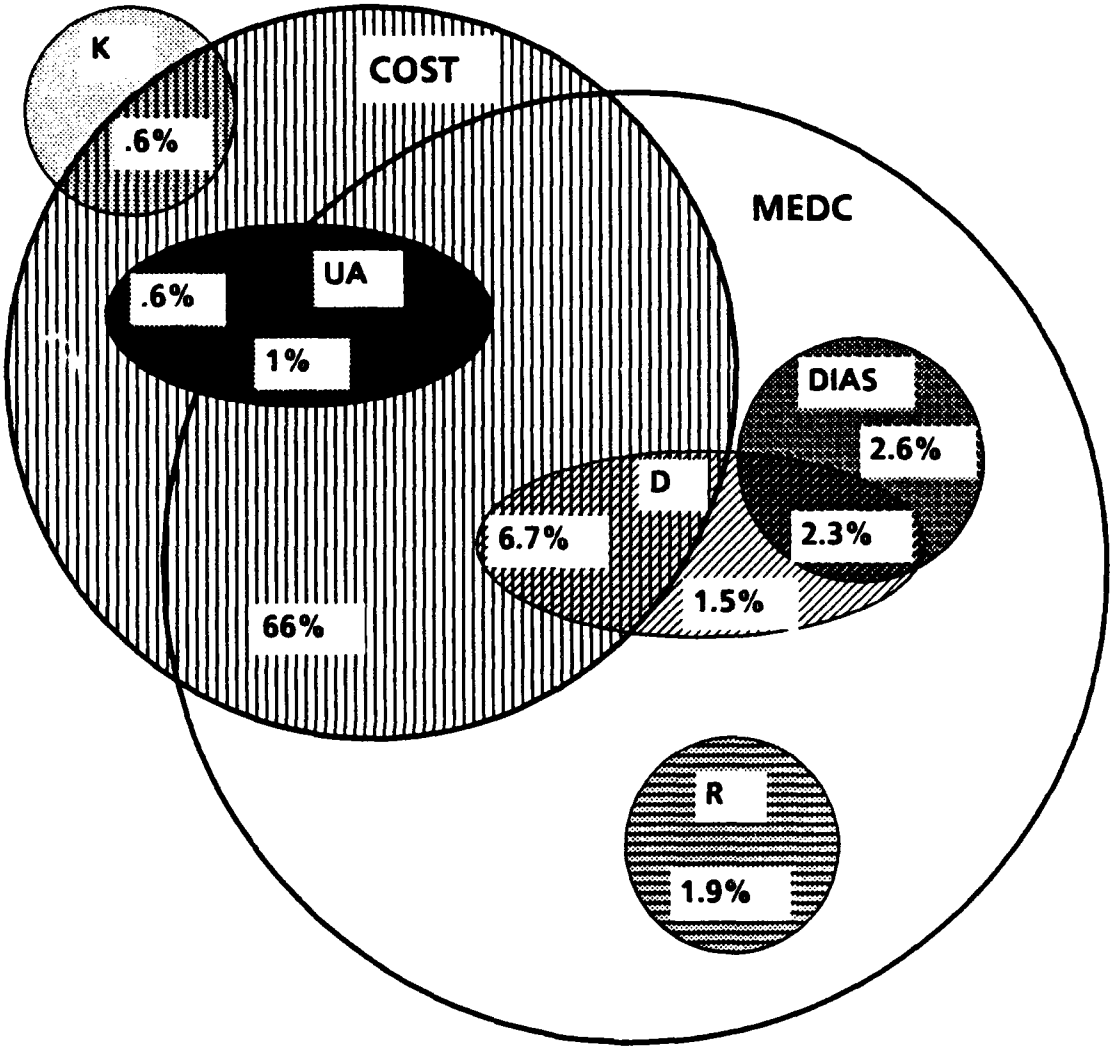
D X MEDC:	8.2%
DIAS X MEDC:	2.5%
R X MEDC:	1.9%
UA X MEDC:	1.0%
DIAS X D:	2.28%

*Effects of all other exogenous variables removed

Combining the results of the two regression analyses into a single graphic model yielded the relationships found in Illustration 6. Uric acid (UA), when used as a predictive variable, simultaneously predicted 1% of MEDC and 1.5% of COST. It therefore appeared that UA was a better predictor of COST. From this same perspective, D would be considered a better predictor of COST, while R a better predictor of MEDC. However, when taken as a group, only 10.5% of the variance of COST versus 13.7% of the variance of MEDC was explained by these clinical, demographic, or control variables. Ultimately, medication complexity (MEDC) has been proven to be the best predictor of COST.

Illustration 6

Relationship of D, DIAS, R, UA and K to MEDC and COST*



COST = -44.129 + 17.122 MEDC + 10.529 K

MEDC = -2.639 + 2.177 D - 0.275 UA + 0.037 DIAS + 1.203 R

SHARED VARIANCE

MEDC X COST:	66.0%
UA X COST:	1.6%
D X COST:	6.7%
UA X MEDC:	1.0%
DIAS X MEDC:	2.6%
D X MEDC:	8.2%
R X MEDC:	1.9%
DIAS X D:	2.3%

*Effects of all other variables removed.

VI. PATIENT-PRACTITIONER INTERACTION MODEL.

The results of both regression analyses were then applied to the patient-practitioner interaction model previously described (see Illustration 1). The first step in this process was to demonstrate the relationship of demographic variables among themselves and to other variables in the study. This is depicted in Illustration 7. For purposes of this portion of the analysis, relationships of all variables that shared greater than 1% variance were depicted.

While there were many interactions among the demographic variables, and relationships between the demographic variables and clinical indicators, only one demographic variable was significantly related to medication complexity (MEDC) : RACE. Again, black patients received a significantly higher medication complexity score, with race explaining 1.9% of that variance.

The relationships of the clinical indicators is depicted in Illustration 8. While many interactions were found to exist, only several of these relationships were significant with regard to medication complexity (MEDC) or COST. Diastolic BP (DIAS) explained 2.3% of COST. Uric Acid (UA) on the other hand, explained 1% and 1.5% of MEDC and COST. Potassium (K) explained only .6% of COST.

Illustration 7

Patient-Practitioner Interaction Model (Demographics)

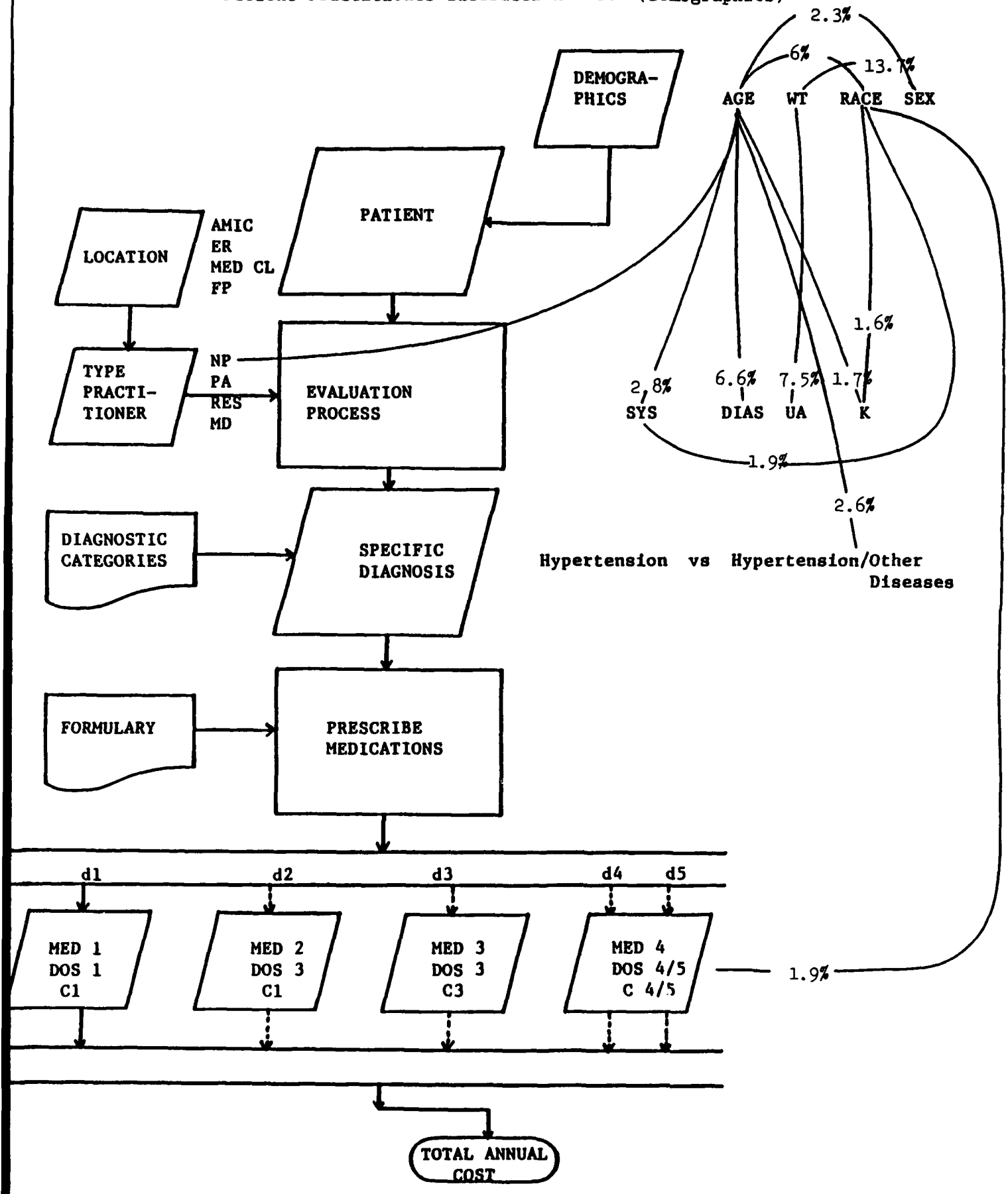
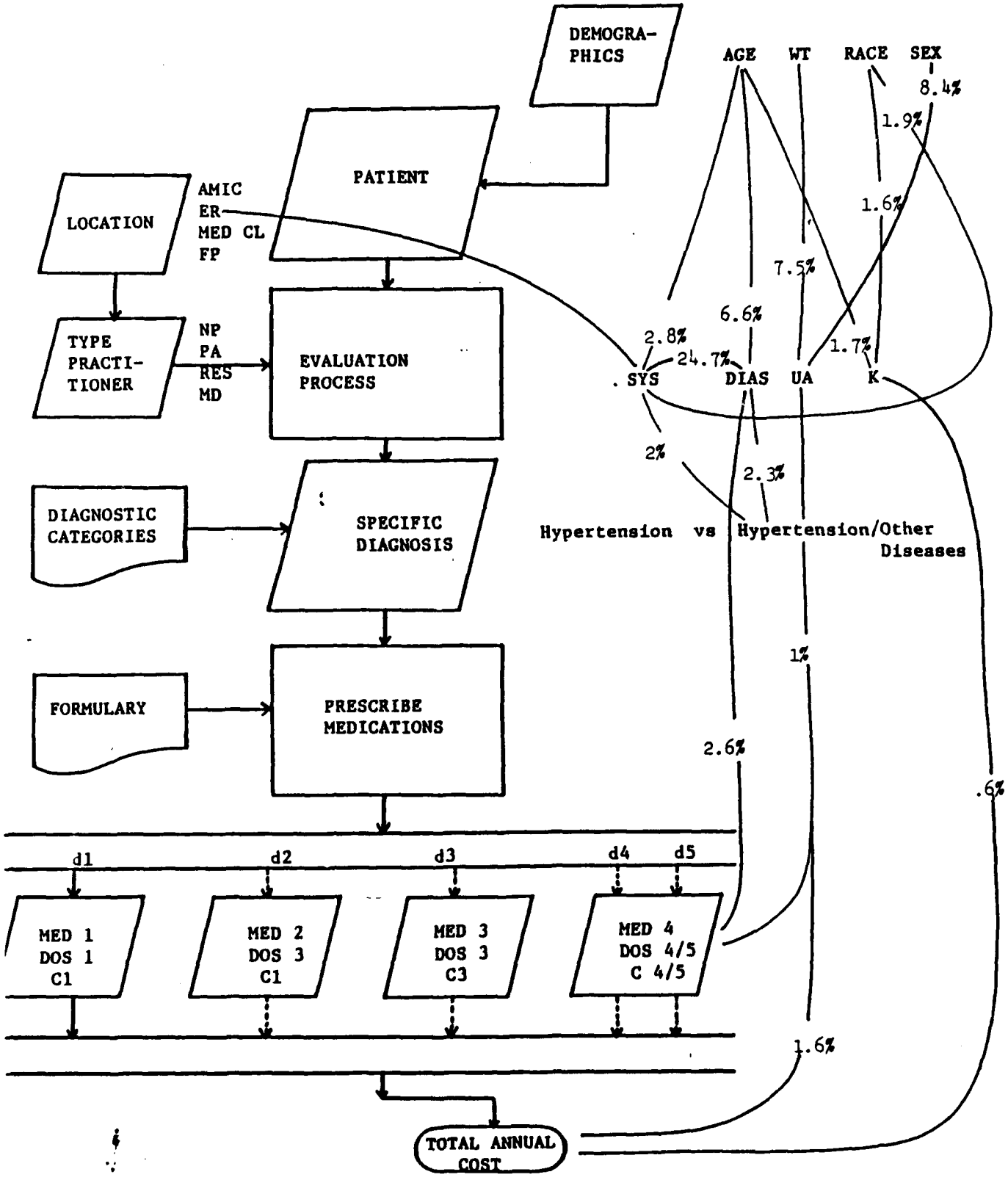


Illustration 8

Patient-Practitioner Interaction Model (Clinical Indicators)



The interactions of the presence of other diseases (D) with other variables were explored and depicted in Illustration 9. Again, several relationships were found, but of greatest importance was the statistically significant relationship between the presence of other diseases and MEDC and COST. The presence of other diseases explained 8.2% and 6.7% of MEDC and COST respectively.

Finally, the relationship of medication complexity (MEDC) to other variables was explored and depicted in Illustration 10. Several relationships were found, but the relationship between MEDC and COST was statistically significant : 66% explained COST variance.

A number of relationships were also found based on type of practitioner (Illustration 11) and location (Illustration 12). The ER was found to be associated with higher systolic blood pressure and presence of other diseases and demonstrated the highest practitioner index value. The medical clinic was found to be associated with greater presence of other diseases while it concurrently demonstrated a low practitioner index value. This appeared to be due to the presence of nurse practitioners who operated a hypertension clinic within the medical clinic. Family practice residents were general y found in the Family Practice Clinic, while physician assistants were typically found in the Acute Minor Illness Clinic and the Emergency Room. Staff physicians were found in all four hospital locations. Physician assistants and staff physicians, however, demonstrated a significantly higher medication complexity index than other practitioners.

Illustration 9

Patient-Practitioner Interaction Model (Presence of Other Diseases)

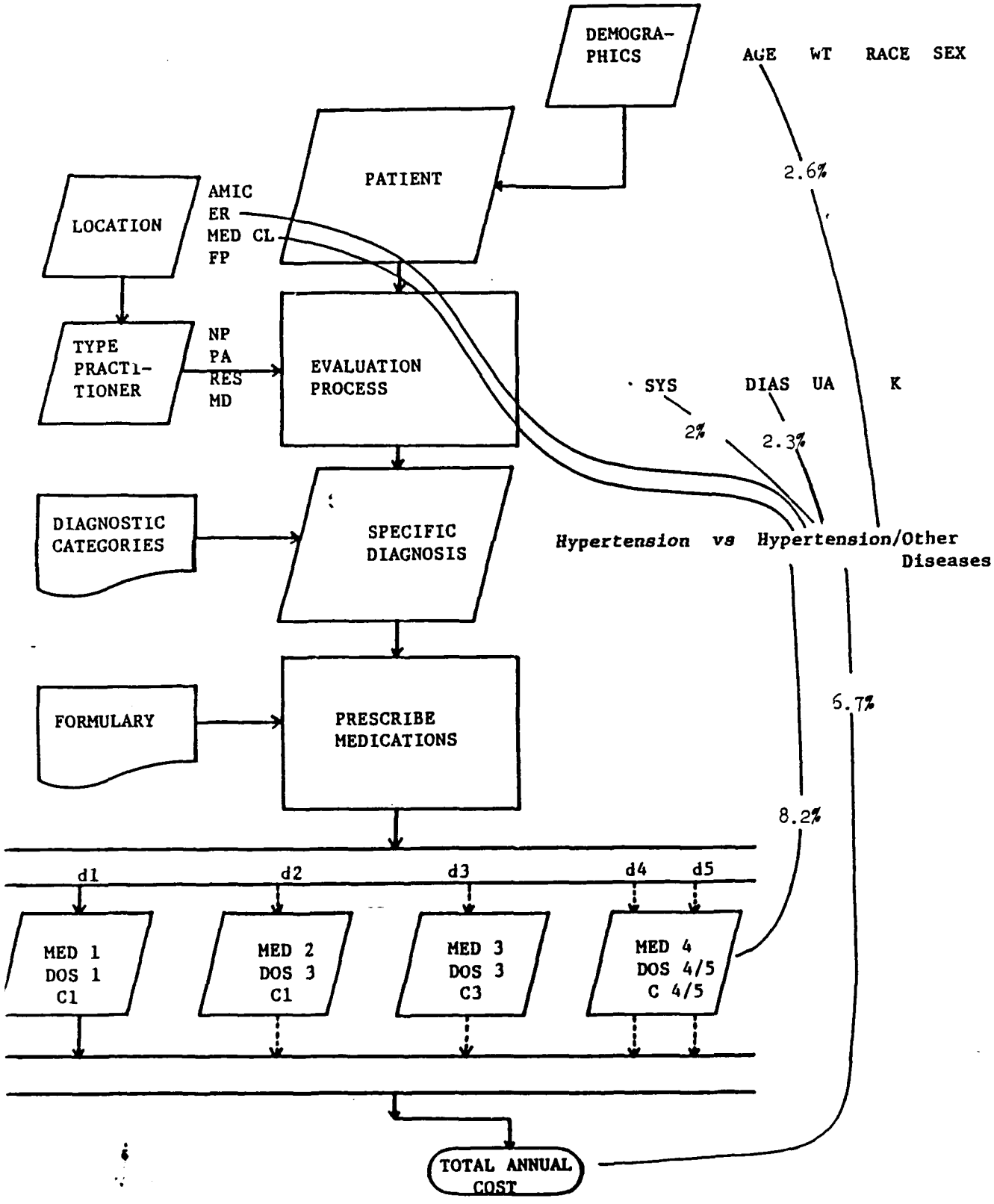


Illustration 10

Patient-Practitioner Interaction Model (Medication Complexity)

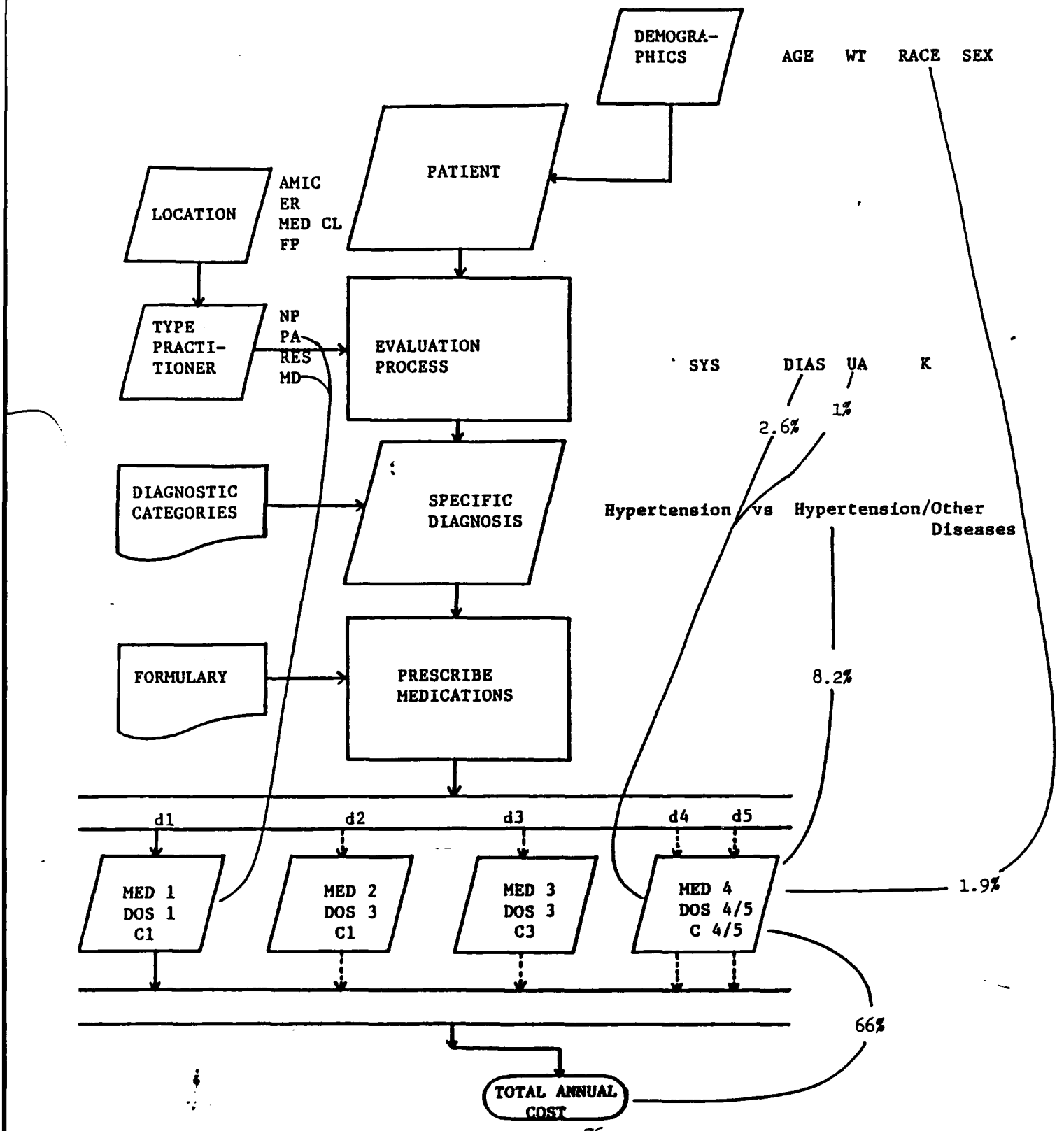


Illustration 11

Patient-Practitioner Interaction Model (Type Practitioner)

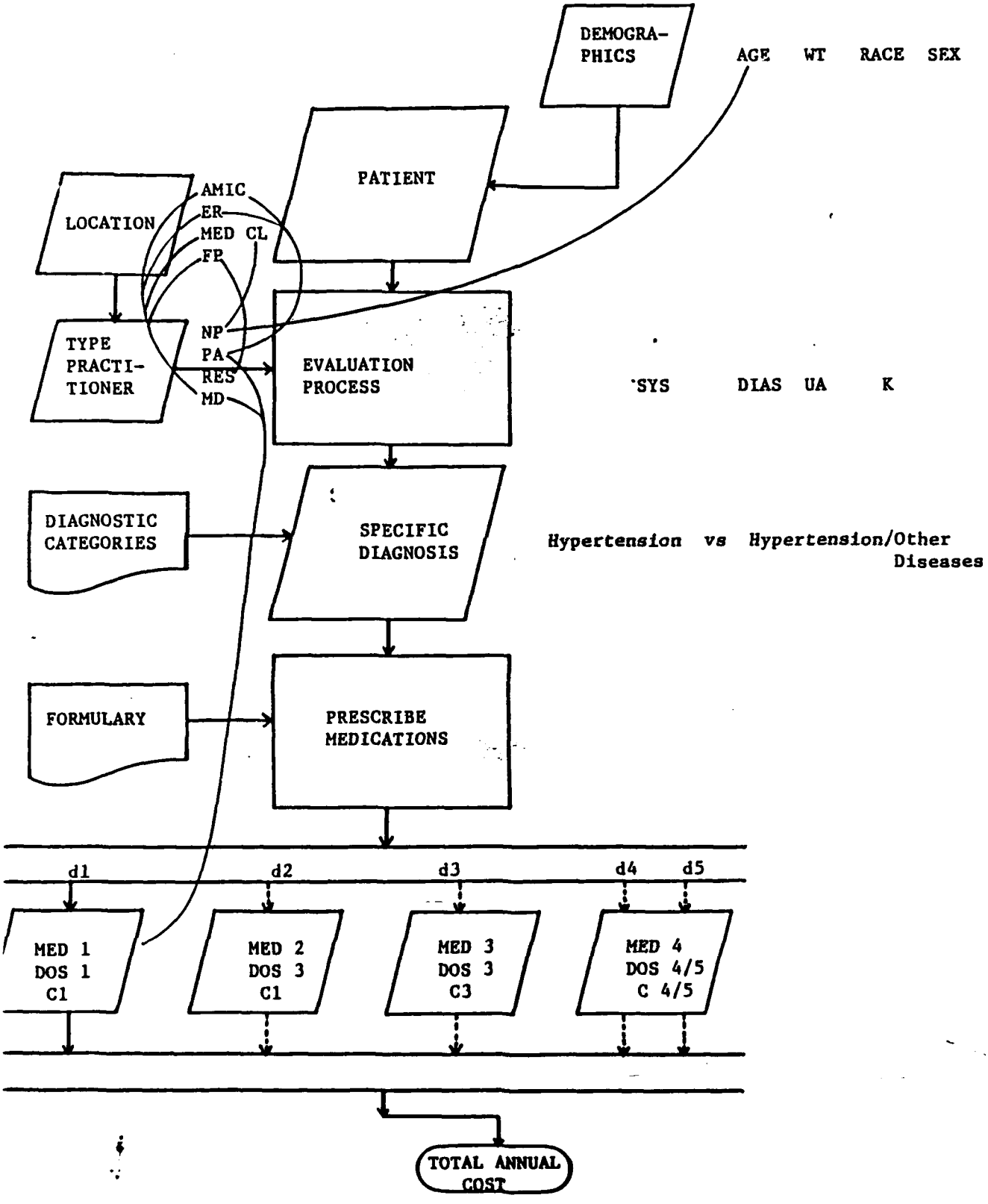
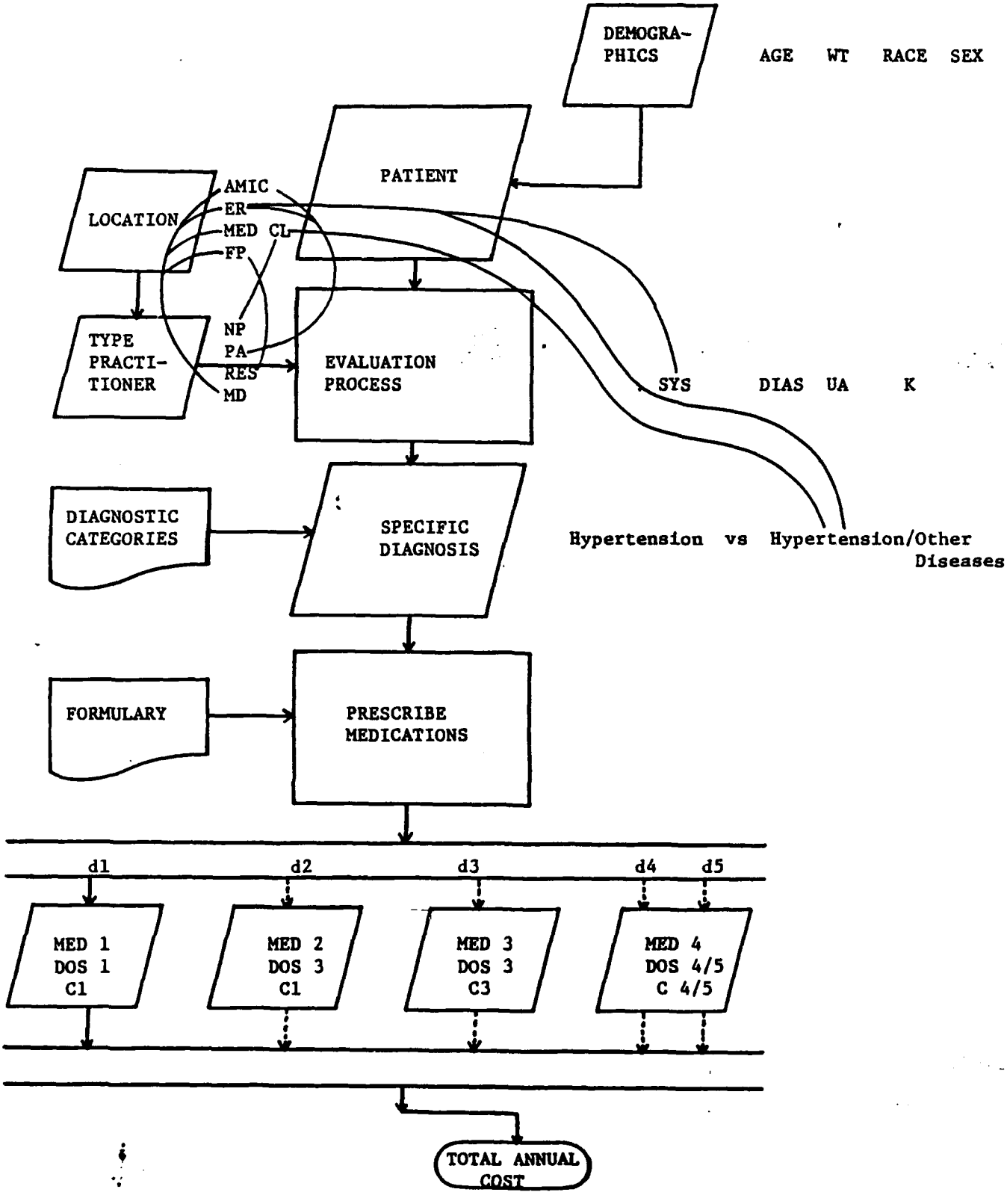


Illustration 12

Patient-Practitioner Interaction Model(Location)

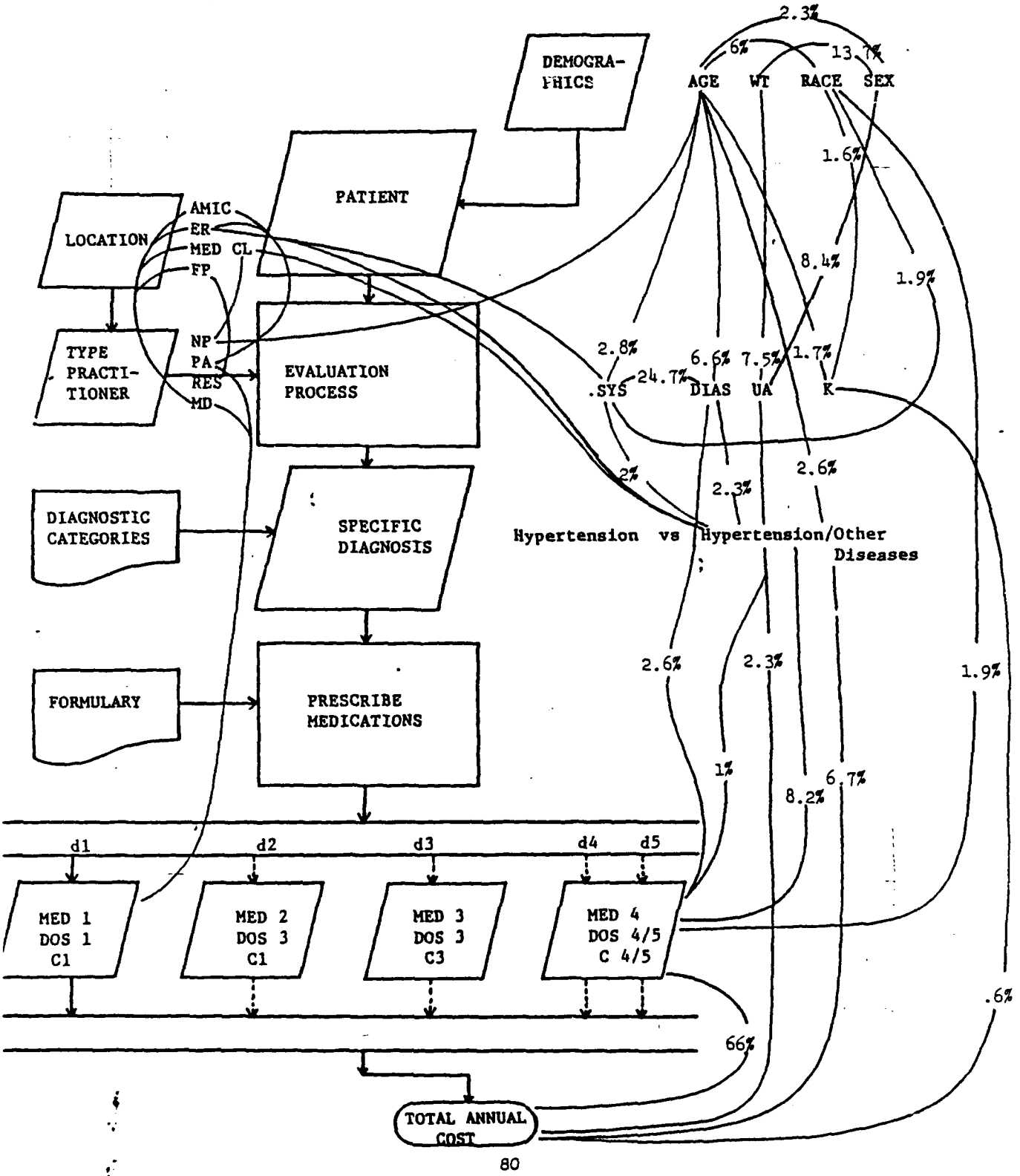


The final step in demonstrating these relationships was to combine the previous six illustrations. This summary illustration graphically represented the treatment of essential hypertension patients at Womack Army Community Hospital (WACH) with regard to demographics, location, type of practitioner, presence of other diseases, medication complexity, and total annual pharmaceutical cost. The complexity of these relationships was clearly revealed and can be found in Illustration 1. This illustration of WACH patient-practitioner interactions was, therefore, a graphic representation of the relationnship of pharmaceutical cost to diagnostic complexity for treatment of essential hypertension at WACH. This provided the basis from which the following questions were assessed: Can WACH predict pharmacy costs? What are the factors that influence pharmacy costs? How can the WACH pharmacy budget be contained or controlled?, and How well do these variables justify annual pharmacy costs?

The results of these analyses indicated that while pharmacy costs could be predicted, the primary predictive variable was medication complexity. The ability to calculate or predict annual costs based on the type and total dosage of medications was found to be analogous to past and current pharmacy cost prediction methodologies. The interesting finding of this study, as demonstrated in Illustration 13, was the identification of those factors that influence annual pharmacy cost either directly or indirectly by influencing medication complexity.

Illustration 13

Patient-Practitioner Interaction Model (Summary)



Understanding these relationships, therefore, assisted in bridging the clinical-administrative gap and presented new opportunities for administrators to measure and influence future utilization trends.

These results also indicated that there was a high potential to contain or control annual pharmacy costs since greater than 34 percent of the variance in COST was unexplained. While the results of previous analyses suggested that the practitioner choice of medication category and dosage had a significant impact on medication complexity and total annual cost, the specific prescribing patterns and variances were not explored. Given the previous results and understanding of the relationships among the study variables, a more thorough analysis of these disease specific patterns of care was considered, and subsequently, conducted. The findings of this analysis can be found later in text.

VII. PRACTITIONER PRESCRIBING PATTERNS.

Based on the results of the initial multiple regression analyses, a closer examination of practitioner prescribing patterns was warranted. As discussed earlier, there was a significant but small relationship between uric acid (UA) and Medication Complexity (MEDC), but no significant relationship between potassium (K) and Medication Complexity (MEDC). In fact, the relationship between potassium (K) and COST was reversed from that expected. While practitioner judgement ultimately determined the final choice of medication (both category and dosage), the medical and pharmacological literature were found to agree on several key factors. When potassium (K) levels fall to 3.5 mg per 100 ml or below, the use of thiazides and most other diuretics would not be warranted. In these cases, non-potassium depleting diuretics (potassium sparing - medication category 3) or more complex non-diuretics (medication category 4) were highly recommended since most non-potassium sparing diuretics excessively deplete extracellular potassium. (Kaplan, 1986, pp 189-255; Goodman & Gilman, 1980, pp 808-814, 870-913). Failure to follow this therapeutic rationale could have potentially resulted in a number of side effects such as muscle weakness, polyuria and an increased propensity toward cardiac arrhythmias.

When uric acid (UA) levels increase to 6.0 mg per 100 ml or above for females or 7.2 mg per 100 ml or above for males, the use of thiazide containing diuretics would not be warranted. The use of non-thiazide other diuretics (medication category 2) or

more complex non-diuretics (medication category 4) were highly recommended since thiazides have been found to induce hyperuricemia by decreasing renal uric acid secretion. Although some question still remained regarding the deterioration in renal function caused by urates, thiazide induced hyperuricemia, and gout should be avoided, particularly in the pre-treatment hyperuricemic patient (Kaplan, 1986, pp 198-199; Goodman & Gilman, 1980, pp 808-814, 870-913).

The data set was then categorized according to potassium (K) level, 3.5 mg per 100 ml and below was low K, above 3.5 mg per 100 ml was normal to high K; and to uric acid (UA) level, 6.0 mg per 100 ml and above was high UA female, below 6.0 mg per 100 ml was normal to low UA female, 7.2 mg per 100 ml and above was high UA male and below 7.2 mg per 100 ml was normal to low UA male. A tabulation of potassium (K) levels groups, by uric acid (UA) groups, is found in Table 21.

Of the four (4) subgroups, three (3) were of immediate clinical significance, n=98, 48.5%, Group 1,1 (low K - normal to low UA) was of concern because of its low potassium (K) level; group 1,2 (low K - high UA) was of concern because of its low potassium (K) and high uric acid (UA) levels and group 2,2 (normal to high K - high UA) was of concern because of its high uric acid level.

The medications prescribed by practitioners were then tabulated by medication categories for each of the four (4) groups listed above. The summary results of this medication category by potassium and uric acid grouping matrix is found in Table 22.

Table 21

Potassium (K) Groups by Uric Acid (UA) Groups Matrix

	Normal to Low UA (1)	High UA (2)	Total
Low K (1)	17	10	27
Normal to High K(2)	104	71	175
Total	121	81	202

Table 22

Medication Category by Potassium (K) Groups and Uric Acid (UA) Groups Matrix

Medication Category	Normal to Low UA (1)		High UA (2)		Total
	Low K (1)	Normal to High K (2)	Low K (1)	Normal to High K (2)	
4	4	29	3	17	53
3	5	43	2	28	78
2	1	5	1	0	7
1	10	35	6	35	86
Total	20	112	12	80	224*

* n = 224 since some patients received more than one medication.

These results indicated that in group 1, 1 (low potassium - normal to low UA) 11 medications prescribed (55%) were thiazides (medication category 1) and/or other diuretics (medication category 2 - potassium depleting), while only 5 medications prescribed (25%) were potassium sparing diuretics (category 3) with the remaining 4 medications (20%) representing the more complex other medications group (medication category 4). Therefore, within this group, some 55% of the medications prescribed warranted review from a quality assurance perspective, since there was an increased potential for clinical interactions to those patients who were prescribed medications categories 1 or 2. This treatment could have depleted existing low potassium levels.

The review of group 2, 1 (normal to high K - normal to low UA) also presented some interesting findings. Forty-three (43) medications prescribed (38.4%) were potassium sparing diuretics (medication category 3) even though their use was not clinically indicated since potassium levels in this group were normal to high. While this may not warrant review from a quality of care perspective, it certainly warranted review from a resource utilization view point, particularly when the average cost of medication category 3 was found to be $96.708 versus $18.176 and $1.10 for medication categories 2 and 1 respectively. The non-clinically indicated choice of medication from medication category 3, therefore, represented a choice costing from 5.3 to 87.9 times more, on the average, than selections from medication categories 2 or 1.

Review of the most diagnostically complex group, group 1, 2 (low K - high UA) again presented some interesting findings. Seven (7) medications prescribed (58.3%) were thiazides (medication category 1) and other diuretics (medication category 2 - potassium depleting). Further, two (2) additional medications prescribed (1.7%) while being classified as potassium sparing diuretics (medication category 3) were combination drugs containing thiazides which could potentially have interacted clinically with these hyperuricemic patients. Given that these choices should also have been avoided, a total of 9 medications prescribed (75%) warranted review from a quality assurance perspective.

Finally, a review of group 2, 2 (normal to high K - high UA) demonstrated that 35 medications prescribed (43.8%) were thiazide diuretics (medication category 1) and could potentially have interacted with these hyperuricemic patients. As discussed previously with group 1,2, the use of thiazide combination diuretics (medication category 3) should have been avoided since the thiazides could have potentially interacted with these hyperuricemic patients. Additionally, potassium sparing diuretics (medication category 3) were not found to be indicated since potassium levels were normal to high. Twenty-eight (28) medications prescribed (35%) were medication category 3. In total, some 63 medications prescribed (78.8%) warranted review from a quality of care or resource utilization perspective.

For this entire study group, a total of 115 medications prescribed (51.3%) warranted review, either from a quality of care or resource utilization point of view. This significant finding (alpha = .05) X^2 (15) = 101.02, $p < .005$ clearly illustrated the large variation in practitioner prescribing patterns at WACH from established treatment protocols in the medical and pharmacologic literature.

VIII. SUMMARY.

Using the regression models developed previously, some 66.6% of the variance of the COST of treatment for essential hypertension patients at Womack Army Community Hospital (WACH) was found. The predictors of COST were found to be plasma potassium (K) level, and medication complexity (MEDC), or when the effects of medication complexity were removed then the presence of other diseases (D), and uric acid (UA) were found to be predictors. The presence of other diseases (D) and increased plasma uric acid (UA) levels all contributed to increased pharmaceutical cost (COST) at WACH. Plasma potassium (K) level was positively related to annual pharmaceutical cost (COST), a relationship that was further explored.

Race (R), uric acid (UA), diastolic BP (DIAS) and the presence of other diseases were all found related to medication complexity (MEDC). The presence of other disease (D), race (R) and increased diastolic BP (DIAS) all contributed to increased medication complexity (MEDC) at WACH. Plasma uric acid (UA)

levels, however, were negatively related to medication complexity, a relationship that was also further explored.

Although there were many interactions among the exogenous variables, the only interactions among COST or MEDC predictor variables was between diastolic BP (DIAS) and presence of other diseases (D). There was a positive correlation and a 2.3% shared variance between these variables. Therefore, as one increased, the other would increase proportional to their shared variance.

While there was no significant relationship of the type of practitioner to COST, there was a significantly higher medication complexity index for staff physicians (MD) and physician assistants (PA) over nurse practitioners (NP) and residents (RES).

Although there were no significant relationships between location and COST or medication complexity (MEDC), the Emergency Room (ER) treated significantly higher systolic BP (SYS), the AMIC and Medical Clinic (MEDCL) treated a greater disease mix and the Emergency Room (ER) demonstrated the highest practitioner index.

Finally, when prescribing patterns were explored to better understand the negative relationships of potassium (K) on COST, and uric acid (UA) on medication complexity (MEDC), a total of 115 medications prescribed (51.3%) were found to warrant review by a quality assurance committee either from a quality of care or resource utilization perspective.

In summary, pharmaceutical cost was found to be most highly related to medication complexity, with medication complexity being related to four (4) diagnostic complexity indicators: presence of other disease (D), diastolic BP (DIAS), uric acid (UA), and race (R). These results seem to indicate that practitioners prescribe without concern to COST. COST was found to be the result of medication complexity (medication category and dosage), although in many cases, the medication category chosen was questioned.

CHAPTER III

CONCLUSION/RECOMMENDATIONS

I. INTRODUCTION.

The results of this study indicated that there was a low relationship between pharmaceutical cost and diagnostic complexity as determined by systolic blood pressure, diastolic blood pressure, plasma potassium level, plasma uric acid level, weight, age, race, sex, or presence of other diseases. These diagnostic complexity variables, particularly the clinical indicators diastolic blood pressure and uric acid level; the control factor presence of other disease; as well as the demographic variable race, better predicted medication complexity than annual pharmaceutical cost. The exact relationship appeared to have been that the clinical indicators diastolic blood pressure and uric acid level; the control variable presence of other diseases; and the demographic variable race, were related to medication complexity which ultimately resulted in a total annual pharmaceutical cost based on the selection of type and dosage of the associated medication.

Specific analyses determined that neither the type of practitioner nor the location of treatment within the treatment facility had any significant impact on COST, although a significantly higher medication complexity index was found to be associated with physician assistants. In fact, an analysis of variance of the medication complexity index indicated that practitioners did not prescribe in relation to their scope of

practice (practitioner index) but in the following order from highest to lowest: physician assistant, staff physician, nurse practitioner, and resident. The expected and perceived roles of these practitioners, as influenced by the high work load and low staffing ratio at WACH, may have contributed to the local delegation of high levels of responsibility and the authority of these practitioners to practice medicine in a broad scope, particularly in the Acute Minor Illness and Medical Clinics.

With a high percentage of prescribed medications warranting review, an increased role for departmental and hospital level quality assurance committee activity must be considered. These activities must include a quality of care and a resource utilization perspective. The quality of care issue would examine both the curing and side effects of medications used, thereby maximizing the curing effect and reducing or eliminating potentially serious side effects. The resource utilization issue would consider the choice of medication after the quality of care issue had been addressed and examine whether a less expensive choice could accomplish the same clinical result. For instance, if Table 21 were adjusted for quality of care and resource utilization, it might look like that shown in Table 23. Using average costs per medication category, a net savings of $4,039.53 would have been realized. Thus, quality of care and resource utilization issues could translate into cost savings and therefore serve to contain costs simply by reducing the variation in prescribing patterns based on diagnostic complexity variables.

The results of this study did not appear to fully justify annual pharmacy expenditures for anti-hypertensive medications. A net savings in excess of four thousand dollars for this sample size could potentially equate to an annual savings of greater than $50,000 (8.3%) for this class of medications alone.

II. RECOMMENDATIONS.

Several recommendations must be considered to improve quality of care and resource utilization with regard to the prescribing of pharmaceutical medications to essential hypertension patients at WACH.

1. Establish clinical monitors for hypertension patients that could be reviewed by both department and hospital level quality assurance committees. This will provide feedback to the appropriate departments/sections or services to either reinforce or admonish the appropriate prescribing behaviors. This could also be applied to other high volume and high cost diseases treated in this and other medical treatment facilities (MTF).

2. Establish a strong clinical hypertension educational program to raise the base knowledge level with regard to appropriate prescribing behaviors for essential hypertension. This is probably the most important adjunct to a successful program designed to enhance quality and resource utilization, without compromising the attitudes or behavioral expectations of practitioners who generally react negatively if their freedom of choice is curtailed or they feel compromised with regard to quality of care. Again, the primary focus must be quality of

care. This issue serves as the common link between practitioners and administrators in the delivery of health care. Unless an issue can be presented within this context, the success of any subsequent administrative change would be dubious.

3. Establish a clinical hypertension newsletter. This can easily be accomplished by the inpatient pharmacy service and can present a rationale for prescribing hypertensive medications given different diagnostic complexities.

4. Establish generally accepted prescribing protocols for hypertensive medications using the forums of the Therapeutics Agents Board (TAB), the Utilization Review Committee (UR), and the clinical staff meeting. Within these groups, practitioners interacting with other practitioners would provide a better environment for change rather than a strict administrative action such as the pharmacy service requesting a change in prescribing patterns. However, this treatment facility does have the ability to restrict medication usage to individual practitioners, types of practitioners, and/or locations through command policy. In this way, quality of care or resource utilization issues could be resolved quickly and therefore could be an effective solution. However, practitioner attitudes and morale may suffer.

5. Improve the drug utilization review program to monitor those medications which are used most (high volume), most toxic, and highest cost. The drug utilization review program should be coordinated with the department and hospital level quality assurance programs. The resulting multidimensional analysis would provide the basis from which the hospital executive

management could make policy decisions to influence the direction of health care in this facility.

6. Continue to predict annual pharmacy costs based on type of medication and total dosage until further studies are conducted to reexamine these quality of care and resource utilization issues.

III. FUTURE RESEARCH

There are many exciting avenues of research open to future administrators and/or clinicians alike. The proposed patient-practitioner interaction model could provide the basis from which to conduct similar analyses of many other specific diagnoses.

In addition, the components of the model could be studied and analyzed on an individual basis. For example, the evaluation process which included patient history, vital signs, triage, ancillary diagnostic support, and other activities, could be further developed to clarify the relationship of these activities to resource utilization on a disease specific, patient specific, and practitioner specific basis. The clinical indicators for each diagnosis must also be defined. Larger study designs would permit analyses to be conducted on an individual drug or practitioner basis.

The impact of the formulary on prescribing patterns is another area of limited research. (See "Analysis of Hospital Formulary Effects," Topics in Hospital Pharmacy Management 2 (August 1982) pp 32-49). Initial findings appear to indicate

that a strong product selection policy which resulted in a reduction in the number of pharmacy products, did not necessarily translate directly into a reduction in inventory value. Such questions as: What is an optimal formulary policy? and How can formulary policy be designed to not only impact on total pharmacy inventory value but also the prescribing patterns of practitioners? must be answered.

A number of complex patient issues are also open for future research. The effects of genetic, environmental, and mixed genetic and environmental could be further explored for a number of disease processes. In fact, the use of the multi-causative model as the basis of disease offers many exciting opportunities to study disease processes. Other related areas of future concern would seem to be the effects of diet, life style, other diseases, and other medications on the disease process. The importance of understanding the interrelation of these multiple causative factors among themselves and to the subsequent disease process cannot be overemphasized. Poor models could result in poor outcomes with regard to treatment and could have significant quality assurance implications not only from a quality of patient care and/or resource utilization perspective, but also as a risk management issue. This could have particular impact on the credentialing of individual practitioners as well as the accreditation of the treatment facility itself.

Finally, research could address the educational and problem resolution aspects of quality assurance as they relate to specific patterns of care. By understanding the factors which

influence prescribing patterns on a specific disease basis, education programs could be tailored to meet the needs of the specific practitioners and treatment facility for specific population basis. Within this rubric, an epidemiologically based model which could be used to predict hospital resource utilization could be of tremendous benefit to the hospital and to health care purchasers.

APPENDIX A

MEDICATION UNIT COST

APPENDIX A

MEDICATION UNIT COST

ITEM	UNIT COST ($)
Aldactone 25MG	0.01
Aldomet 250MG	0.13
Aldomet 500MG	0.03
Aldactazide	0.03
Blocadren 10MG	0.32
Catapres 0.1MG	0.14
Catapres 0.2MG	0.28
Corgard 40MG	0.30
Corgard 80MG	0.41
Hygroton 50MG	0.02
Hygroton 100MG	0.15
Inderal 40MG	0.08
Lasix 40MG	0.01
Lopressor 50MG	0.09
Loniten 10MG	0.32
Minipres 1MG	0.12
Minipres 2MG	0.18
HCTZ 50MG	0.003
Reserpine 0.25MG	0.002
Tenormin 50MG	0.27
Tenormin 100MG	0.39
Vasotec 5MG	0.42
Vasotec 20MG	0.63
KCL 40 MEQ	0.14
Diuril 500MG	0.003
Viskin 5MG	0.12
Viskin 10MG	0.15
Dyazide	0.20
Procardia 10MG	0.49

APPENDIX B

DESCRIPTION OF VARIABLES

APPENDIX B

Description of Variables

MEDC	The medication complexity calculated by MEDC = (MED1 X DOS1) + (MED2 X DOS2) + (MED3 X DOS3)
SYS	The actual numerical systolic blood pressure reading in mm mercury which prompted the initiation of drug therapy
DIAS	The actual diastolic blood pressure reading in mm mercury which prompted the initiation of drug therapy
K	The plasma potassium level in mg per 100 ml ordered immediately prior to or at the time of initiation of therapy
WT	The actual weight in pounds documented immediately prior to or at the time of initiation of therapy
AGE	The actual age in whole years documented immediately prior to or at the time of initiation of therapy
P	The ordinal value of the type of practitioner who initiated the drug therapy as derived from Table 4.
S	The ordinal value for sex, transformed from the categorical values male and female, M=1; F=2
R	The ordinal value for race, transformed from categorical values white, black, asian, hispanic, W=1; B=2
D	The ordinal value for other disease processes present (restricted to cardiovascular, renal and pancreatic) transformed from categorical values yes, no. Y=1; N=2
COST	The total annual cost calculated by multiplying the daily usage rate (dose) x 365 days times the FY86 unit cost. If multiple medications were prescribed, the total cost equation would become:

COST = (MED1 unit cost x DOS1 X 365) +
(MED2 unit cost X DOS2 X 365)....

APPENDIX C

PERSON CORRELATION MATRIX

APPENDIX C

PEARSON CORRELATION MATRIX

	COST	MEDC	SYS	DIAS	K	UA	WT	AGE	S	R	D	P
COST	1.000											
MEDC	0.813	1.000										
SYS	0.046	0.123	1.000									
DIAS	0.113	0.161	0.497	1.000								
K	0.067	-0.008	-0.068	-0.064	1.000							
UA	-0.121	-0.098	-0.050	-0.046	0.043	1.000						
WT	-0.082	-0.104	-0.057	-0.042	0.027	0.273	1.000					
AGE	-0.020	-0.007	0.167	-0.257	0.131	0.065	0.027	1.000				
S	-0.036	0.000	0.072	0.006	-0.123	-0.289	-0.370	-0.193	1.000			
R	0.060	0.138	-0.137	0.004	-0.127	0.084	0.051	-0.245	0.035	1.000		
D	0.258	0.287	0.142	0.151	0.040	0.029	-0.032	0.161	-0.077	-0.020	1.000	
P	0.060	0.092	0.044	0.085	-0.004	0.019	-0.058	-0.192	0.031	0.060	0.061	1.000

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